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**U.S. ARMY ENVIRONMENTAL CENTER**

**WOODBIDGE RESEARCH FACILITY  
REMEDIAL INVESTIGATION/FEASIBILITY STUDY**

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**Remedial Investigation  
Volume I  
Text, Tables, and Figures**

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**Remedial Investigation  
Volume II  
Appendices**

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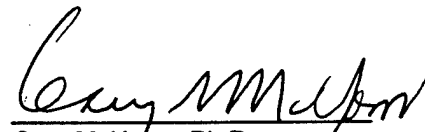
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REMEDIAL INVESTIGATION  
WOODBIDGE RESEARCH FACILITY

FINAL DOCUMENT

  
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## LIST OF ACRONYMS AND ABBREVIATIONS

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°F .....	degrees Fahrenheit
ACM .....	asbestos-containing material
AREE .....	Area Requiring Environmental Evaluation
ARL .....	Adelphi Research Laboratory
ASTM .....	American Society for Testing and Materials
AWQC .....	ambient water quality criteria
BCF .....	bioconcentration factor
BCT .....	BRAC Cleanup Team
bgs .....	below ground surface
BNA .....	base neutral/acid-extractable compound
BRAC .....	Base Realignment and Closure
BTEX .....	benzene, toluene, ethylbenzene, and xylenes
CEC .....	cation exchange capacity
CEQ .....	Council on Environmental Quality
CERCLA .....	Comprehensive Environmental Response, Compensation, and Liability Act
COC .....	Chain-of-Custody
CONUS .....	Continental United States
COPC .....	Chemical of Potential Concern
DDD .....	1,1-dichloro-2,2-bis(p-chlorophenyl)ethane
DDE .....	1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene
DDT .....	1,1,1-trichloro-2,2-bis(chlorophenyl)ethane
EEQ .....	Environmental Effects Quotient
EQL .....	estimated quantitation limits
ERA .....	Ecological Risk Assessment
ER-L .....	Effects Range-Low
ER-M .....	Effects Range-Median
ESE .....	Environmental Science and Engineering, Inc.
FAC .....	Facultative Plan
FACW .....	Facultative Wetland Plan
FFS .....	Focused Feasibility Study
FS .....	Feasibility Study
GAQ .....	Geotechnical Aquifer Testing File
GFD .....	Geotechnical Field Drilling File
GGs .....	Geotechnical Groundwater Stabilized File
GIS .....	Geographical Information System
GMA .....	Geotechnical Map File
GPS .....	Global Positioning System
GWC .....	Geotechnical Well Construction File
HHRA .....	Human Health Risk Assessment
ICF KE .....	ICF Kaiser Engineers, Inc.

I.D.	inner diameter
IDW	Investigation-Derived Waste
IRDMIS	Installation Restoration Data Management Information System
L/min	liters per minute
LOC	Level of Concern
MERDC	U.S. Army Mobility Equipment Research and Development Center
mph	miles per hour
msl	mean sea level
NEPA	National Environmental Policy Act
NVCC	Northern Virginia Community College
NWI	National Wetland Inventory
OBL	Oblique Wetland Plan
OCDD	octachlorodibenzo-p-dioxin
O.D.	outer diameter
OU	Operable Unit
PAH	polynuclear aromatic hydrocarbon
pCi/L	picocurie per liter
PCB	polychlorinated biphenyl
PCT	polychlorinated terphenyl
PID	Photoionization Detector
PPE	personal protective equipment
ppm	parts per million
ppt	parts per thousand
PVC	polyvinyl chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Remedial Action
RBC	risk based concentrations
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RME	reasonable maximum exposure
RPD	relative percent difference
SARA	Superfund Amendments and Reauthorization Act
SAV	submerged aquatic vegetation
SC	Site Characterization
SI	Site Investigation
SOP	Standard Operating Procedure
SSI	Supplemental Site Investigation
SVOC	semivolatile organic compound
TAL	Target Analyte List
TCL	Target Compound List
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbon

TRV..... toxicity reference value  
USAEC..... U.S. Army Environmental Center  
USCS..... Unified Soil Classification System  
USEPA..... U.S. Environmental Protection Agency  
USFWS..... U.S. Department of Fish and Wildlife Service  
UST..... Underground Storage Tank  
VEPCO..... Virginia Electric Power Company  
VADEQ..... Virginia Department of Environmental Quality  
VOC..... volatile organic compound  
WRF..... Woodbridge Research Facility



**Section 1.0**  
**Introduction**

## **1.0 INTRODUCTION**

ICF Kaiser Engineers (ICF KE) has been contracted by the U.S. Army Environmental Center (USAEC) to conduct a Remedial Investigation/Feasibility Study (RI/FS) for the U.S. Army Woodbridge Research Facility (WRF). This task is being performed under Contract No. DACA31-94-D-0064, Delivery Order 0001. This Remedial Investigation (RI) Report describes the site background, presents a conceptual hydrogeologic model of the site, summarizes previous investigations, describes the technical approach for the RI, and summarizes the results of the RI. A summary of the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) is also presented.

The RI is being conducted in accordance with the U.S. Environmental Protection Agency (USEPA) guidance documents developed for activities performed under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). In addition, the RI/FS is being performed in compliance with USAEC Technical Guidance and Quality Assurance (QA) requirements; the National Environmental Policy Act of 1969 (NEPA); and the President's Council on Environmental Quality (CEQ) regulations (40 CFR 1500-1508). The procedures used in the study are consistent with the Department of the Army's environmental policy toward integrating the NEPA and CERCLA/SARA processes.

WRF is located in Prince William County, Virginia and is approximately 22 miles southwest of Washington D.C. The facility was included on the 1991 Base Realignment and Closure (BRAC) list. An RI is being conducted at the facility to evaluate the nature and extent of contamination associated with past activities and to evaluate the level of risk posed to human health and the environment. The goal of the RI is to gather and present information that will allow appropriate risk management decisions to be made regarding evaluation and selection of remedial actions at the site. Focused Feasibility Studies (FFS) have been performed for Operable Units (OUs) defined for the site and consist of the identification, preliminary screening, detailed evaluation, and comparison of remedial alternatives which are capable of mitigating site conditions.

This study is being performed under the purview of the U.S. Army, USEPA Region III, and the Virginia Department of Environmental Quality (VADEQ).

### **1.1 PURPOSE OF THE REPORT**

In accordance with the BRAC, an RI/FS was conducted to evaluate the nature and extent of environmental contamination at the site. This report is a presentation of the findings of the RI/FS. Tasks completed for the RI/FS included preparation of three risk assessments, which were performed to evaluate the potential impacts to human health and/or the environment. Also included in this RI report is a summary of the remedial actions, which may be implemented at this installation to protect human health and the environment.

WRF has 49 sites of concern identified as Areas Requiring Environmental Evaluation (AREEs). Previous investigations have shown that contaminated media exists at many of these AREEs. The AREEs have been grouped into OUs based either on their proximity to one another or similarities with regard to contaminated media. OU1 (approximately 24 acres) has been defined as the area of WRF bounded by Deephole Point Road to the east, Lake Drive to the west, and Marumsco Creek and Occoquan Bay to the south. OU1 is comprised of AREEs 1 through AREEs 6B (Former Dumps) and AREE 7 (Former Pistol Range). OU2 has been defined as the Main Compound Area. The Main Drainage Ditch, and the portions of AREE 11 and AREE 17 that are outside of the Main Compound fence have been designated as OU3. OU4 comprises all other areas at the facility.

The RI activities performed were designed to fully evaluate the AREEs associated with WRF and utilize these data to develop remedial alternatives for the OUs as appropriate. As stated previously, FFSs have been prepared for each OU at WRF. The data gathered during the RI and FFSs are presented in this report, along with summaries of data generated during environmental studies conducted prior to this RI. Also presented in this report are the results of the HHRAs and ERAs.

## 1.2 REPORT ORGANIZATION

The RI Report for WRF is organized into 12 sections, as follows:

Section 1.0 - Introduction

Section 2.0 - Facility Background. The physical setting of WRF, site geology, and the site history is presented.

Section 3.0 - Site Conceptual Hydrogeologic Model. The conceptual hydrogeologic model is presented in this section. It has been developed using data gathered from the installation of monitoring wells and piezometers for the RI. Water level maps have been prepared using water level data gathered during the RI.

Section 4.0 - Wetland Delineation. A wetland delineation for WRF was performed as part of the RI. The procedures for the performance and the results of the survey are presented in this section. A wetland delineation map for the site is presented in this section.

Section 5.0 - Previous Investigations. Past investigations, which have identified the need for follow-up investigations performed as part of the RI, are described.

Section 6.0 - Technical Approach. Rationale for the scope of the RI is presented which includes a description of all activities that have been performed as part of this RI.

Section 7.0 - Summary of Investigations. The results of the fieldwork, that was conducted as part this RI, are summarized in this section. The chemical data are summarized in detection tables that are grouped by AREE within its appropriate OU. This section also gives a brief summary of the conclusions drawn from the results of the RI investigations on an OU basis. The Installation Restoration Data Management Information System (IRDMIS) data package is included in Appendix D of this RI report.

Section 8.0 - Quality Assurance/Quality Control. This section describes the quality control (QC) and QA procedures used during the RI. Analytical data reduction, validation procedures, and completeness are also presented.

Section 9.0 - Contaminant Fate and Transport. This section evaluates the fate and transport of several contaminant constituents and their interactions with the environment at WRF. The section briefly presents the current theories of fate and transport of contaminants in the environment.

Section 10.0 - Summary of Human Health and Ecological Risk Assessments. HHRAs and ERAs were conducted for each OU1, OU3, and OU2/4(site-wide risk assessments) for the facility. A summary of these assessments is presented in this section. The detailed risk assessments for each OU is included in this RI report as Appendix A, HHRAs and Appendix B, ERAs.

Section 11.0 - Conclusions. This section presents a summary of the RI findings which includes results of all environmental sampling for each OU.

Section 12.0 - References

**Section 2.0**  
**Facility Background**

## **2.0 FACILITY BACKGROUND**

The following sections present existing information regarding WRF. This includes information describing the physical setting of the area and a summary of past activities at the installation (site history).

### **2.1 PHYSICAL SETTING**

WRF occupies 579 acres in the eastern-most portion of Prince William County, Virginia, as shown in Figure 2-1. The town of Woodbridge is located less than 1.5 miles west of WRF and has a population of 30,860 (Weston, 1992). The site is 22 miles southwest of Washington, D.C.

U.S. Census Bureau Tract No. 9001.00, which encompasses WRF and the land immediately adjacent to the facility, contains an estimated 1,216 residents (Weston, 1992). Prior to construction of WRF in 1951, the site was used primarily for agricultural purposes, most notably in the northern portion.

The property immediately to the north of the WRF installation east of Dawson Beach Road is presently being developed to include a private golf course, residential housing, and a marina. To the north of WRF, and west of Dawson Beach Road, the installation is adjoined by a former military housing area as well as by commercial property. The facility is bounded on the west by Marumsco Creek and the Marumsco National Wildlife Refuge tidal wetlands. West of Marumsco Creek is Veteran's Memorial Park, a recreation area administered by Prince William County. The southern edge of the property is shoreline, facing Belmont Bay and Occoquan Bay.

#### **2.1.1 Climatology**

The climate at WRF is variable, influenced by the Chesapeake Bay and the Atlantic Ocean to the east and the Appalachian Mountains to the west. The weather is characterized by cold, dry, continental-polar winds from the west and northwest during the winter, and maritime-tropical winds from the south and southwest (which bring warm and often humid air to the region) in the summer. During the summer, occasional air pollution episodes are created when high-pressure systems stagnate over the area.

Rainfall averages 38.88 inches per year. Snowfall averages less than 10 inches per year. The annual mean daily temperature for the area is 57 degrees Fahrenheit (°F). The monthly mean temperature ranges from 29°F in January to 90°F in July. The growing season, based on average first and last killing frosts, is from April 15 to October 15 (ESE, 1981). Prevailing winds are generally from the south in the summer months and the north to northwest in the winter months. The average wind speed is 7.1 miles per hour (mph).

#### **2.1.2 Site Physiography and Topography**

WRF lies within the western portion of the Coastal Plain Physiographic Province, approximately eight miles east of the Fall Line that separates the Coastal Plain Physiographic Province from the Piedmont Physiographic Province. The facility is located on a neck of land at the southern edge of the embayed mouth of the Occoquan River, where it empties into Belmont Bay and Occoquan Bay. These bays in turn feed the Potomac River and the Chesapeake Bay. The northern portion of the facility is situated on the post-Pleistocene terrace of the Potomac River, while the southern portion of the facility is marsh, underlain by alluvium from Potomac River and Occoquan River terrace deposits.

Elevations at the site range from less than 2 feet to over 30 feet above mean sea level (msl). The highest elevations are in the northern and western portions of the site. There are flat-lying areas along the southern and southeastern coastal areas of the site and relatively steep slopes along the southwest coastal areas (facing Marumsco Creek) and in the central area (facing the Main Ditch and the southeast marshy area) of the site.

WRF is located in the drainage basin of the Occoquan Watershed and is composed primarily of terrace and alluvial deposits from the Potomac River and the ancestral Potomac River. Cobbles and gravels originate from the ancestral Potomac and include a variety of cherts, rhyolite, silicified sandstone, and quartz. Tributary streams, such as the Occoquan River and Marumsco Creek also carry this material as they cut through the various cobble deposits and quartz float and veins in the adjacent

Piedmont. Some larger cobbles and boulders possibly originated from ice rafting mechanisms (Ward, 1991) associated with late Sangamon glaciation.

The Occoquan River and Marumsc Creek are the east and west boundaries of the promontory of land on which WRF is located. The land area is primarily drained by one surface drainage feature that originates off site and enters the property near the Dawson Beach Road entrance to WRF. This primary drainage channel (designated as the Main Drainage Ditch) is joined by at least three other tributaries before it reaches Occoquan Bay, just west of Deep Hole Point. A topographic map of the WRF area which includes site (Diamond Laboratories) is presented in Figure 2-2. Past site activities have included the deepening and straightening of this drainage channel as well as the construction of drainage pathways between existing (natural) drainage features. The property is divided generally into marshy areas (elevations less than 10 feet msl) and non-marshy (upland) areas. Surface drainage from the upland areas appears to flow either toward the Occoquan Bay or to the area of the Main Ditch where it is directed toward the southeastern marshy areas of the site.

The lithology of the bottom sediment within Marumsc Creek and the drainage ditches located within WRF is controlled by current-velocity distributions. Coarse-grained materials are typically found in the areas where current velocities are insufficient to transport these materials and yet sufficient to transport the fine-grained materials. Organic-rich, fine-grained material settles out of suspension in more dormant areas of creeks and drainage ditches. Tidal currents in Belmont and Occoquan Bays are such that the bottom sediments are composed of sand, which is coarser along the shoreline due to wave action.

### 2.1.3 Soil Types

The general soil types found in the eastern Woodbridge vicinity are the Dumfries-Lunt-Marr soil association (USDA SCS, 1989). Six soil types have been specifically identified at WRF and are described below.

*Delanco Series.* These soils are very deep and moderately-drained. They formed on alluvial terraces on the Piedmont Plateau, and are subject to rare flooding. Slopes range from 0 to 4 percent.

*Dumfries Series.* The soils of the Dumfries series are typically very deep and well-drained. They formed in feldspathic sandy sediments of the Coastal Plain. These soils are found on narrow ridges and side slopes. Slopes range from 7 to 50 percent.

*Elsinboro Series.* These soils are very deep and well-drained. They formed in sediments dominantly derived from schist, gneiss, and granite of the northern Piedmont Plateau. They are found on low stream terraces adjacent to floodplains. Flooding is rare. Slopes range from 2 to 7 percent.

*Featherstone Series.* The soils of the Featherstone series are very deep and very poorly-drained. They formed in Coastal Plain sediments at an elevation of less than 2 feet. The water table is commonly at the surface, and most areas are subject to ponding. Slopes range from 0 to 1 percent.

*Marumsc Series.* These soils are very deep and moderately well-drained to somewhat poorly drained. They formed in stratified marine sediments of the low Coastal Plain Terraces. These soils are found in depressional areas. Slopes range from 0 to 4 percent.

*Meadowville Series.* These soils are very deep and well-drained to moderately well-drained. They formed partly in colluvial materials and partly in materials weathered from muscovite, schist, and gneiss. They are found in depressional areas on toe slopes, along drainage ways, and in saddle positions in the northern part of the Piedmont Plateau. These soils are flooded for very brief periods after heavy rains. Slopes range from 0 to 5 percent.

### 2.1.4 Regional Geology

WRF is located in the Atlantic Coastal Physiographic Province, which is characterized by an eastward thickening wedge of unconsolidated sand, silt, and clay sedimentary units. The Coastal Plain

sediments begin at the Fall Line and thicken to the east and southeast. The sediments are underlain by undifferentiated Paleozoic meta-sedimentary and meta-igneous rocks. Three wells were installed into the lower Potomac aquifer in the central part of the WRF in the early 1950s. Two of the wells were installed by the Army to a depth of approximately 105 feet below ground surface (bgs). These two wells, which provided drinking water to the installation for a number of years, did not encounter bedrock. However, a third well, installed by the Commonwealth of Virginia in late 1950 encountered bedrock (granite) at a depth of 151 feet bgs. Locally, the unconsolidated sediments include the Potomac Group of the Cretaceous age, which are overlain by terrace and alluvial deposits of Pleistocene and Holocene age.

The Potomac group consists of three different facies that thicken from a feather edge along the northwest margin of outcrop in Dale City and Agnewville, to about 300 feet in the Marumsco Woods area of Woodbridge.

The more abundant facies, denoted Type 1, consist of cross-bedded very light gray to pinkish gray or greenish-gray, medium-to-coarse feldspathic quartz sand locally oxidized to yellow, orange, and brown. The matrix is clay-silt that may constitute 40 percent or more of the sediment. Gravelly sands contain pebbles and cobbles of vein quartz and quartzite or, less commonly, other metamorphic rock types. The sediments in the Type 1 facies probably represent channel-lag and channel-bar or point-bar deposits.

Type 2 facies consist of greenish-gray silty clay; clayey silt; and clayey, fine sand commonly mottled red or reddish-brown. Clay-silt plugs, ranging from 2 to 10 feet in thickness and 60 feet or more in width, are commonly formed within a dominantly medium to coarse sand sequence. These plugs may be the result of filling of abandoned stream channels by fine sediments during flood stages.

The Type 3 facies occurs as thin to thick beds within Type 1 sediment, suggesting deposition in swampy areas of floodplains. These sediments consist of dark yellowish-brown to olive-gray lignitic sandy silt and clay containing well-preserved leaf and stem impressions of ferns, cycads, and gymnosperms.

Quaternary deposits (QT2 and QP2) are gravelly and sandy deposits which underlie the lower two terraces of ancestral Potomac and Occoquan Rivers. These deposits occur under terraces in valleys of Pohick Creek and Giles Run and are graded to the same level as the more extensive Potomac River terraces in adjacent areas. Units correlate with Potomac River deposits mapped in the Quantico quadrangle (Mixon et al., 1972).

QT2 deposits consist of loose-crossbedded, medium to coarse, partly pebbly, feldspathic quartz sand, and massive to thick-bedded clayey and silty sand commonly pale yellowish-gray to reddish-gray. Pebbles are mostly quartz, metamorphic rocks of various types, red shale, and sandstone. The unit is very poorly exposed within the map area, but representative sections are well exposed in wave-cut cliffs bordering Occoquan Bay.

QP2 deposits consist of sand, gravel, and feldspathic quartz sand very similar to QT2 deposits. Basal beds are commonly cobble gravel composed mainly of quartz, quartzite, and lesser amounts of chert and sandstone. These deposits are confined to small hilltop areas near the mouth of the Occoquan River and to the Gunston Heights area of Mason Neck. QP2 is much more extensive east and northeast of the map area in the northern part of Mason Neck, lower Pohick Creek drainage basin, and in the vicinity of Fort Belvoir.

The alluvium deposits of Holocene age consist of mud, sand, and gravel that form narrow floodplains along minor streams. These deposits are found in swamps and marshes bordering tidal tributaries of the Potomac River. They may include some colluvium.

#### **2.1.4.1 Site Geology**

The discussion of the site geology within this section is limited to the interpretation of information acquired during the USAEC 1995 RI field work, therefore, interpretations concerning bedrock geology are not included.

A geologic map has not been developed specifically for the site, however, reconnaissance mapping can be completed based on site specific information such as topography and boring logs. The site topography can be divided into two general areas. The first is a low and relatively flat-lying area along the reaches of the Main Ditch and to the south and east of the site which is marshy nearest the shore. The second is the northern, central, and western areas of the site which are higher in elevation and exhibit an undulating land surface. Based on the regional geologic map, as presented in Figure 2-3, (Mixon et al., 1972) and the site information, the higher portions of the site are probably underlain by terrace deposits of the ancestral Potomac River and the lower areas are probably areas where terrace deposits have been eroded away (if ever present) and where more recent stream/river deposits overlie the ancestral Potomac River deposits.

#### **2.1.4.2 Site Hydrogeology**

The site hydrogeology is presented in Section 3.0 as the Conceptual Hydrogeologic Model.

## **2.2 SITE HISTORY**

In 1952, the property was assigned to the U.S. Army Command and Administrative Communications Agency and designated the Army Transmitting Station. In 1962, the Station was reassigned to the U.S. Army Continental United States (CONUS) Regional Communications Command and redesignated as the East Coast Radio Transmitting Station. In 1965, the Station was placed under the U.S. Army Strategic Communications Command. The Station was inactive for one year, from July 1969 to July 1970, before the U.S. Army Mobility Equipment Research and Development Center (MERDC) administered the station. At this time, seven acres reserved for housing were transferred to Fort Belvoir, which is located approximately six miles northeast of the WRF. In 1971, a consolidation of USAMC nuclear weapons effects research and test activities resulted in the transfer of 642 acres of the land to Harry Diamond Laboratories of Adelphi, Maryland. The site was designated the Woodbridge Research Facility and in August 1973, 63 acres of the installation in the vicinity of Marumsco Creek were transferred to the U.S. Department of the Interior for use as a park and wildlife refuge (Marumsco National Wildlife Refuge), and the Electromagnetic Effects Laboratory was physically relocated from Fort Belvoir to WRF.

In 1991, the Defense Base Realignment and Closure Commission recommended realignment of the Army activities being conducted at WRF. In October 1992, Harry Diamond Laboratory was absorbed into the Adelphi Research Laboratory (ARL) in Adelphi, Maryland, and most activities were relocated to the Adelphi Laboratory Center in Adelphi, Maryland. The WRF was closed as an active Army facility on September 16, 1994. The property will be transferred to the U.S. Department of Fish and Wildlife Service for use as a wildlife refuge some time in the near future.

WRF has 49 sites of concern identified as AREEs. These AREEs are shown in Figure 2-4 and 2-5. Table 2-1 presents a listing of the AREEs. Previous investigations have shown that contaminated media exists at many of these AREEs. Based on the results of the RI, the AREEs were grouped into OUs. OU1 (approximately 24 acres) has been defined as the area of WRF bounded by Deephole Point Road to the east, Lake Drive to the west, and Marumsco Creek and Occoquan Bay to the south. OU1 is comprised of AREEs 1 through AREEs 6B (Former Dumps) and AREE 7 (Former Pistol Range). OU2 has been defined as the Main Compound Area. Refer to Figure 2-5 for the location of the AREEs within the Main Compound (OU2). The Main Drainage Ditch and portions of AREE 11 and AREE 17 that are located outside the fenced part of the Main Compound has been designated as OU3. OU4 comprises all other areas at the facility. The boundaries for OU1, OU2, and OU3 are depicted on Figure 2-4.



**Section 3.0**  
**Conceptual Hydrogeologic Model**

## **3.0 CONCEPTUAL HYDROGEOLOGIC MODEL**

### **3.1 INTRODUCTION**

The basic components of the conceptual hydrogeologic model for the WRF are presented here to support the interpretations concerning the occurrence and movement of groundwater beneath the WRF site. Physical characteristics of the site and subsurface geology are provided below as well as general interpretations concerning the occurrence and movement of shallow groundwater.

### **3.2 SITE SETTING AND CLIMATE**

The WRF is located in the easternmost area of Prince William County, Virginia near the mouth of the Occoquan River where it empties into Belmont Bay. The climate at the site is variable due to the proximity of both the Chesapeake Bay (and Atlantic Ocean) and the Appalachian Mountains. Average annual rainfall is more than 38 inches and the annual mean daily temperature is 57°F. The coldest month is January and the hottest month is July; the growing season lasts from mid-April to mid-October. Prevailing winds are generally from the south in the summer and from the north/northwest in the winter.

### **3.3 TOPOGRAPHY AND DRAINAGE**

Ground surface elevations at the site range between less than 2 feet to over 30 feet msl. The highest elevations are in the northern and western portions of the site. There are flat-lying areas along the southern and southeastern coastal areas of the site and relatively steep slopes along the southwest coastal area (facing Marumsco Creek) and in the central area of the site (facing the Main Ditch and southeast marshy area). Figure 3-1 is the detailed site topographic map that was constructed with aerial photo data.

The WRF site is situated within the Occoquan River basin at its discharge point into Belmont Bay. The Occoquan River and Marumsco Creek are the east and west boundaries of the promontory of land on which WRF is located. The WRF facility is drained by one surface water channel that originates off site and enters the site property near the Dawson Beach Road (Route 687) gate. This primary drainage channel is joined by at least three other tributaries before it reaches Belmont Bay, just north of Deep Hole Point (see Figure 2-2 and Figure 3-1). Past site activities have included the deepening and straightening of this drainage channel as well as the construction of drainage pathways between existing (natural) drainage features. Because of the known modifications to the natural drainage, this primary discharge channel has been named the "Main Ditch".

As shown on the topographic map (Figure 3-1), air photos, and observations made during site visits, the facility property is divided generally into marshy areas (elevations less than 10 feet msl) and non-marshy (upland) areas. Surface drainage from the upland areas appears to flow either toward Occoquan Bay or to the area of the Main Ditch where it is directed toward the southeastern marshy areas of the site.

### **3.4 GEOLOGIC FRAMEWORK**

This section presents information on the physical characteristics of the subsurface materials at WRF. General characteristics of soils, geology and stratigraphy are presented below.

#### **3.4.1 Soils**

The soils at WRF have not been mapped specifically. However, the Prince William County soil map indicates that the soils beneath the site include the Dumfries-Lunt-Marr unit and associated soil from the Neabsco-Quantico-Dumfries unit. The following section is a summary of the information provided in the Soil Survey of Prince William County, Virginia (USDA SCS, 1989).

##### **3.4.1.1 Dumfries-Lunt-Mar**

These are very deep, well drained soils that have a loamy or clayey subsoil. This soil unit consists of gently sloping to very steep soils on terraces. The soils are underlain by fluvio-marine sediments of sand, silt, clay, and gravel. Minor soil associations in lowland tidal areas include the Featherstone soils.

1. The *Dumfries* soils are on strongly sloping to moderately steep side slopes. They are well drained, very deep, and have a loamy subsoil.
2. The *Lunt* soils are on gently sloping to moderately steep side slopes. They are well drained, very deep, and have a clayey subsoil.
3. The *Marr* soils are strongly sloping to moderately steep. They are very deep, well drained, and have a high content of fine sand and very fine sand.
4. The *Featherstone* soils are present at low elevations. They are very deep, level to nearly level, and very poorly drained.

The Weston (1992) document provided more site-specific information regarding site soils. However, the information reported there has not been corroborated with either the reference provided or follow-up investigation.

### 3.4.2 General Geology

The WRF site is located within the Coastal Plain Physiographic province which is characterized by a thick wedge of unconsolidated to loosely consolidated sediments ranging in age from Cretaceous to Recent.

Mixon et al. (1989)<sup>1</sup> report that the WRF is underlain by Quaternary-age sediments that were deposited during interglacial high stands of the sea. Two members of the Tabb Formation (Upper Pleistocene) are shown at the site (see Figure 2-3). This formation is comprised of gravel, sand, silt, clay and peat lithostratigraphic units of coast-parallel plains and includes coeval terrace deposits along major rivers. Stratigraphic analysis of this section of the Coastal Plain sequence has been difficult and as a result, the Tabb Formation was defined in order to clarify stratigraphic problems encountered by regional stratigraphers (Johnson and Peebles, 1991). In summary of their work, the distribution of facies within this formation is complex as it reflects both deposition and erosion throughout at least three cycles of transgression/regression within the alluvial depositional setting.

A geologic map has not been developed specifically for the site. However, reconnaissance mapping can be completed based on the Mixon et al. (1989) map and site-specific information such as topography and boring logs. First, the site topography can be divided into two general areas: 1) a low and relatively flat-lying area along the reaches of the Main Ditch and to the south and each of the site which is marshy nearest the shore; and 2) the northern, central, and western areas of the site which are higher in elevation and exhibit an undulating land surface (see Figure 3-1). Based on the regional geologic map (Mixon et al., 1989), information available in Froelich (1985) and existing site information, the higher portions of the site are probably underlain by terrace deposits of the ancestral Potomac River and the lower areas are probably areas where terrace deposits have been eroded away (if ever present) and where more recent stream/river deposits overlie the ancestral Potomac River deposits.

### 3.4.3 Site Stratigraphy

Cross sections prepared for the WRF site illustrate the complex distribution of subsurface geologic materials. Figure 3-1 depicts cross section locations on a site-wide topographic map. Figures 3-2 through 3-11 are the geologic cross sections prepared using boring log data for monitoring wells installed at the site. Boring log data are presented in Appendix C. The cross sections depict the variability in site subsurface sediments. For example, the subsurface stratigraphy presented in cross section A-A' (Figure 3-2) includes units composed of either clay, silt, sand, or gravel and units composed of mixtures of these materials. The correlations shown on A-A' illustrate the laterally and vertically discontinuous nature of the stratigraphic units<sup>2</sup>. Cross section B-B' (Figure 3-3) illustrates what appears to be more continuity in the stratigraphic units. It should be noted that this apparent continuity may be a

<sup>1</sup> This is a large-scale map of Virginia and, therefore, does not provide geologic detail at the site. A literature search at the U.S. Geological Survey failed to identify any small scale geologic mapping in this area of Prince William County. However, a Fairfax County geologic map (Froelich, 1985) shows similar geology on the land parcel adjacent to the northeast of WRF.

<sup>2</sup> Stratigraphic units are discontinuous due to depositional (facies changes) and erosional factors.

function of well and/or sample spacing rather than actual conditions. The actual variability in geologic materials may be much greater than that depicted on the cross sections because, in a typical sampling program, wells are not spaced closely enough to allow the delineation of each sand or clay layer/lens in a heterogeneous system. In other words, additional wells installed along any cross section may show that the stratigraphic units are not as extensive as currently shown. Therefore, correlations shown on the cross sections should be considered estimated. The cross sections are useful, however, in illustrating the heterogeneous nature of the subsurface stratigraphy at WRF (vertically and laterally discontinuous units with highly variable grain-size distributions).

Cross section A-A' shows porous, water-bearing units/lenses of silty sand, sand, and gravelly sand overlain by a more continuous unit of silty clay that thins to the southwest near Occoquan Bay. The silty sand and sand units depicted on B-B' are also overlain by a silty clay layer that thins near Occoquan Bay. Cross section C-C' (Figure 3-4) depicts permeable units of sand, gravelly sand, and sandy silt that appear to be interbedded or grade into one another so that they may be hydraulically connected. These units are overlain by silty clay that thins on both sides of the section where it nears Occoquan Bay. Cross section D-D' (Figure 3-5) depicts interbedded units of silty sand, sand, gravel, and silty clay. Silty clay makes up the surficial deposits except at well MW-76, near Occoquan Bay, where sand outcrops at the surface. Subsurface geologic deposits in the area of the site covered by cross sections A through D appear to have been deposited in an alluvial setting. For example, note the grading of grain sizes in A-A' where sand and gravelly sand in well MW-80 appears to grade into sand that grades into silty sand in well MW-60. Similar gradation can be seen in cross section C-C' where sandy silts grade into sand that grades into gravelly sand. The apparently extensive units of near-surface clay and silty clay could have been deposited during interglacial periods. The thinning of surficial clay deposits near the Bay indicates that this layer has apparently been eroded away by surface water bodies.

Cross sections E-E' and F-F' (Figures 3-6 and 3-7) depict stratigraphy similar to that discussed above. Porous, water-bearing units of sand, gravelly sand, and silty sand could be hydraulically connected due to gradation between units. Water-bearing units are overlain by a unit of silty clay and clay that appears to be continuous near the surface. This surficial clay unit does not thin or pinch out because these cross sections are not as close to the Bay or Marumsco Creek as cross sections A through D. In fact, the surficial clay unit becomes thicker in upland areas such as beneath the Main Pond near PZ-12 on cross section F-F'.

Cross sections G-G' and H-H' (Figures 3-8 and 3-9), again, are similar to the other cross sections in their depiction of water-bearing units that may be hydraulically connected overlain by a mostly continuous layer of clay/silt. Cross section G-G' depicts a few water-bearing units of sand and gravelly sand that do not appear to be hydraulically connected to other water-bearing units. These units are overlain by a layer of silty clay that likely causes aquifer conditions in these units to be confined. Cross section H-H' depicts more porous units that could be hydraulically connected. Because of the hydraulic connection, these units may act together as one aquifer. This aquifer unit is overlain by a layer of clay and silty clay that could act as a confining unit. However, the clay unit is broken by a silt unit near the surface at MW-66. In the area of this well, the aquifer could be under unconfined conditions or semi-confined conditions if the silt layer is compacted and/or contains clay.

Cross section I-I' (Figure 3-10) was constructed to depict stratigraphic conditions in the area of the Main Ditch. This cross section shows discontinuous, water-bearing units overlain by silty clay or clay that is thicker in upland areas. Based on the presence of clay near the surface in most areas of the site, the Main Ditch is likely underlain by a clay layer that separates it from hydraulic connection to deeper water-bearing units. However, there are not enough wells installed in the Main Ditch area to confirm this theory. Cross section J-J' (Figure 3-11) depicts similar conditions beneath the Main Building area. Note that two well clusters were used in cross section J-J'. In well cluster MW-62/56, only lithologic data from well MW-56 was used in the cross section because MW-62 was drilled using the mud rotary method that does not allow the collection of detailed lithologic data. In well cluster MW-39/84, only lithologic data from well MW-84 was used because well MW-39 is shallow and the boring log does not provide as much lithologic data as the log for MW-84. The boring logs for both wells show similar lithologies, however, MW-39 notes a sand-gravel-silt material of unknown thickness at approximately 6 feet msl that was not noted in MW-84.

In summary, the stratigraphy at WRF is characterized by zones/lenses of porous, water-bearing materials that are hydraulically connected in many areas but are discontinuous in others. These water-bearing units are overlain in most areas of the site by a clay layer that thins near the Bay and thickens in upland areas.

### 3.5 AQUIFER SYSTEM FRAMEWORK

The shallow groundwater flow system beneath the WRF site is composed of laterally discontinuous clay, silt, sand, and gravel units of varying thickness and sorting that were deposited in an alluvial setting. Hydrostratigraphic units have not been defined at the site because of these lateral and vertical discontinuities, or heterogeneity. Boring logs for on-site monitoring wells suggest that the primary water-bearing units at the site are composed of sand or sand and gravel that is often present below dry clay or silt units (or poorly-sorted mixtures of silt and clay with sand). Because of the high degree of heterogeneity in geologic materials at the site, the extent to which those water-bearing units are hydraulically connected is not known. Therefore, distinct aquifer units have not been identified at the WRF.

Table 3-1 summarizes important hydrogeologic information for most of the monitoring wells at the site. Boring logs were reviewed for each of these wells to estimate the approximate thickness of dry clay or silt above the screened interval, the depth at which water was first encountered during drilling, the number and types of different lithologies screened by each well, and the local aquifer condition at each well. The local aquifer condition (unconfined, confined, or semi-confined) was estimated based on the lithology in each borehole, the elevation of the top of the water-bearing unit screened by the well and the stabilized groundwater elevation. Groundwater elevations and monitoring well data are presented in Appendix C.

From the geologic cross sections it is clear that most wells have several feet of low-permeability material (clay or silty clay) at the surface. An examination of geologic information and groundwater elevation at each boring reveals that most wells have a groundwater elevation that rises above the top of the water-bearing unit(s) screened by the well. These observations indicate the presence of confined or semi-confined aquifer conditions within the water-bearing units in the subsurface. Figure 3-12 is a graphical representation of this condition for the PZ-06 location that shows approximately 20 feet of dry clay and clay/silt mixtures overlying moist clay and saturated, gravelly sands. The groundwater elevation in PZ-06, however, rises more than 20 feet above the top of the gravelly sand water-bearing unit screened by the well. More than half of the monitoring wells listed on Table 3-1 exhibit confined or semi-confined conditions similar to those represented in Figure 3-12<sup>3</sup>.

Figure 3-13 is a bar graph of two parameters for each well. The first parameter is the difference in feet between the elevation at which water was first encountered in each of the borings and the elevation at which the water level in the well stabilized (data presented in Table 3-1). This water level variance value is plotted beside the second parameter, the thickness of clay above the well screen. It is clear that there is a positive correlation between these two parameters. Therefore, at well locations where thick clay units were observed above the screen, the equilibrated water level measured in the well strongly suggests confined to semi-confined conditions at that depth. However, it should be noted that unconfined conditions appear to exist in several wells (see Table 3-1). These wells are located in both upland and low-lying areas across the site and do not appear to be present in a particular pattern that would indicate unconfined conditions in specific areas. Rather, aquifer conditions are believed to be a function of local lithology at each well.

The complex stratigraphy at the site precludes detailed analysis of any particular hydrostratigraphic unit because the extreme heterogeneity in subsurface geologic materials cannot be fully characterized with standard monitoring well design and placement. The level of detail attained using existing monitoring well data is insufficient to define hydrostratigraphic units or to map water levels in each unit beneath the site. For example, monitoring well MWV-60 on cross section A-A' is screened

<sup>3</sup> Because subsurface samples were collected at five-foot intervals, only wells with a boring/well variance of more than five feet are included in this count. Those wells with variances less than five feet are not reliable indicators of confined conditions, although future water level measurements may support the presence of either hydraulic condition.

across a low-permeability unit of interbedded clay and silt, a water-bearing unit of silty sand, and a unit of silty clay. The resulting groundwater elevation is an average of the hydraulic head in each of these geologic units. Such an average does not allow an accurate evaluation of the hydrogeologic conditions present in the water-bearing unit screened by that well. Therefore, groundwater elevation data used to construct water level maps at this site do not accurately reflect the local-scale groundwater flow conditions in the water-bearing units screened by each well. It should be noted that groundwater elevation data used to construct groundwater contour maps for this site must be clearly identified as to what unit(s) those data represent and what condition is implied with boring data (i.e., confined versus unconfined) such as that provided in Table 3-1.

### 3.6 GENERALIZED GROUNDWATER FLOW SYSTEM

Two main factors have led to the belief that although complex, the lithologic units in the shallow groundwater system at WRF are probably hydraulically connected throughout the area of the facility. First, the proximity of the regional discharge point (Occoquan Bay) suggests that all groundwater flow in the shallow subsurface will converge on the base level represented by the Bay. For groundwater to reach this regional discharge area, either preferred hydraulic connection pathways exist between water-bearing units or enough leakage occurs through the low-permeability zones separating water-bearing units that water moves from water-bearing unit to water-bearing unit until it reaches the regional discharge area.

Second, when the water level distribution at the site is contoured in the context of both stratigraphy and topography (the main controlling factors), the conditions under which groundwater exists are reflected in the contours. In other words, in areas of low topography (where the thinning or absence of a surficial clay layer allows water-bearing units to be under unconfined condition) the water level contours mimic site topography. At higher elevations, the water level contours (representing water levels within more porous water-bearing units under confined conditions) do not necessarily mimic site topography because groundwater flow in upland areas is controlled by the thickness and distribution of water-bearing units and not on localized surface topography. For example, on cross section H-H' water levels are near the surface in wells installed in areas of low topography (MW-69, MW-65, MW-66, and MW-67) whereas water levels in wells installed in areas of higher elevation (MW-59 and MW-60) are much lower.

The variable topography and complex stratigraphy described in Sections 3.3 and 3.4.2 appear to be the controlling factors on groundwater occurrence in the shallow subsurface at this site. These factors control whether groundwater occurs under unconfined or confined conditions<sup>4</sup> at any given depth and location. The subsurface stratigraphy also controls whether water-bearing units are hydraulically connected to one another. Because of these factors, the resulting water level distribution measured from on-site wells is not what one might expect for typical shallow groundwater (water table) conditions. In other words, because the monitoring wells at the site are not screened in one discrete aquifer<sup>5</sup>, the water level distribution measured from on-site wells does not represent any particular hydrostratigraphic unit; rather, it represents averaged, or composite, water levels in the shallow subsurface at the site.

Because the water level distribution is complex and aquifer units have not been defined at the site, many interpretations of small-scale groundwater flow patterns can be developed based on the data currently available. In this section, two different interpretations of groundwater flow are presented. The first assumes that water-bearing units are hydraulically connected, leading to an equilibration of water levels regardless of local aquifer conditions (confined or unconfined). The second assumes less hydraulic connection and aquifer conditions that are more dependent on the stratigraphy at each well. The small-scale groundwater flow patterns in either interpretation could prove to be realistic. However, both interpretations show that the larger-scale groundwater flow pattern at the site is radial with water

<sup>4</sup> This assumption is based on boring log and water level data collected at the site to date.

<sup>5</sup> Monitoring well screens are the standard length of 10 feet and, therefore, are open over two or more different lithologies. The resulting water level represents the (weighted) average water-level condition in each of the screen lithologies. This fact even further complicates the understanding of water level distribution at the site. It should be noted that: 1) the monitoring wells were installed to intercept the uppermost water-bearing unit; and 2) that prior to installation of the monitoring wells, little was known about the subsurface at WRF. Therefore, the use of 10-foot screens for wells at this site was an appropriate use of standard well installation methods.

traveling from recharge areas to the north and northwest of the site toward the regional discharge point of Occoquan Bay.

The first interpretation of groundwater flow is presented in a composite water level map for the site, Figure 3-14. This map combines both water table conditions in low-lying areas of the site (where water levels mimic site topography) and confined or semi-confined conditions in the upland areas of the site (where water levels are independent of site topography) into one map to illustrate the complexity of shallow groundwater flow patterns. It is believed in this interpretation that both confined and unconfined conditions can be represented on a single contour map because water-bearing units are hydraulically connected, resulting in an equilibration of water levels with the regional base level. Therefore, regardless of local aquifer conditions, the nearby regional discharge area is a base level to which water levels equilibrate.

Small-scale groundwater contours are complex, with flow generally moving from topographic highs to lows. The Main Ditch appears to be hydraulically connected to water-bearing units, resulting in unconfined conditions immediately north of the Main Building area. However, further upstream from that location the lack of wells prevents the characterization of the hydraulic relationship between the surface and groundwater. In the remaining areas of the site, radial groundwater flow dominates.

The second interpretation of groundwater flow is presented in additional groundwater elevation contour maps. Four different contour maps were created based on screen midpoint elevation. Wells whose screen midpoint falls within a 10-foot range in elevation were contoured on one map to illustrate the point that small-scale groundwater flow patterns cannot be adequately characterized with the given data, however, larger-scale radial groundwater flow toward regional discharge locations remains evident. These groundwater contour maps, Figures 3-15 through 3-18, depict the behavior of groundwater at four different depths within the shallow aquifer system, 10 to 0 feet msl, 0 to -10 feet msl, -10 to -20 feet msl, and -20 to -30 feet msl. The wells in these maps were assumed to be under a more confined aquifer condition than that depicted in the composite groundwater contour map (Figure 3-14). Therefore, surface water features such as the Main Ditch do not have as much control over groundwater contours on these potentiometric surface maps.

Figure 3-15 presents groundwater contours based on groundwater elevations for wells whose screen midpoint falls between 10 and 0 feet msl. On this map, groundwater moves from the northwestern portion of the site radially toward surface water bodies (Marumsco Creek, Occoquan Bay, and Belmont Bay). Figure 3-16 provides a similar representation for wells whose screen midpoint falls between 0 and -10 feet msl. Figure 3-17 presents contours constructed based on groundwater elevations for wells with screen midpoint between -10 to -20 feet msl. Radial groundwater flow is also apparent based on these contours. However, groundwater contours in the area just north of the Main Building area have an unusual bend. This bend could be accounted for if a zone of high hydraulic conductivity exists in a north-south orientation in the area of MW-57. A high-conductivity zone in this area would cause groundwater contours to be refracted from surrounding low-conductivity areas toward the MW-57 area. Another explanation for such curvature of groundwater contours in this area is the presence of unconfined conditions at MW-57 and confined conditions in surrounding areas. Figure 3-18 presents groundwater contours based on groundwater elevations for wells whose screen midpoint falls between -20 to -30 feet msl. Radial groundwater flow is apparent based on these contours. On these groundwater contour maps, there is very little interaction between small surface water features (such as the Main Ditch) and groundwater due to the presence of a confining clay unit that separates water-bearing units from surface water bodies.

Because the nature of the aquifer is not simple, nor is it well defined, either of the above interpretations of groundwater flow at WRF may represent the actual groundwater flow condition. However, both interpretations indicate that, on a larger scale, radial groundwater flow is present from upland areas toward regional discharge points such as Occoquan Bay, Marumsco Creek, and Belmont Bay.

### 3.7 SUMMARY

The hydrogeology at the WRF is characterized by complex stratigraphy and variable topography. Therefore, these factors are important in determining aquifer conditions and groundwater flow patterns

beneath the site. The geologic materials beneath the site are a heterogeneous mixture of clay, silt, sand, and gravel. Porous, water-bearing units were deposited as discrete zones or lenses while clay layers appear to have been deposited as more continuous units. Due to heterogeneity, the permeability of subsurface materials changes dramatically from point to point beneath the site. Because these small-scale changes can not be delineated with the available data, the degree of hydraulic connection between water-bearing units is not known. Therefore, both unconfined and confined conditions may exist beneath the site. As a result, two interpretations of groundwater flow have been presented here, one that assumes primarily unconfined conditions and one that assumes confined conditions. These two interpretations of groundwater flow depend on the degree of hydraulic connection between water-bearing units. To define the degree of hydraulic connection between water bearing units at the site, a higher level of data is required than is available currently. Additional lithologic data would be required to determine whether water-bearing units are continuous or discrete. In addition, to define the hydraulic character of these water-bearing units, wells must be installed and carefully screened in the water-bearing unit of interest only to obtain groundwater elevations that are reflective of the hydraulic character of the aquifer material.

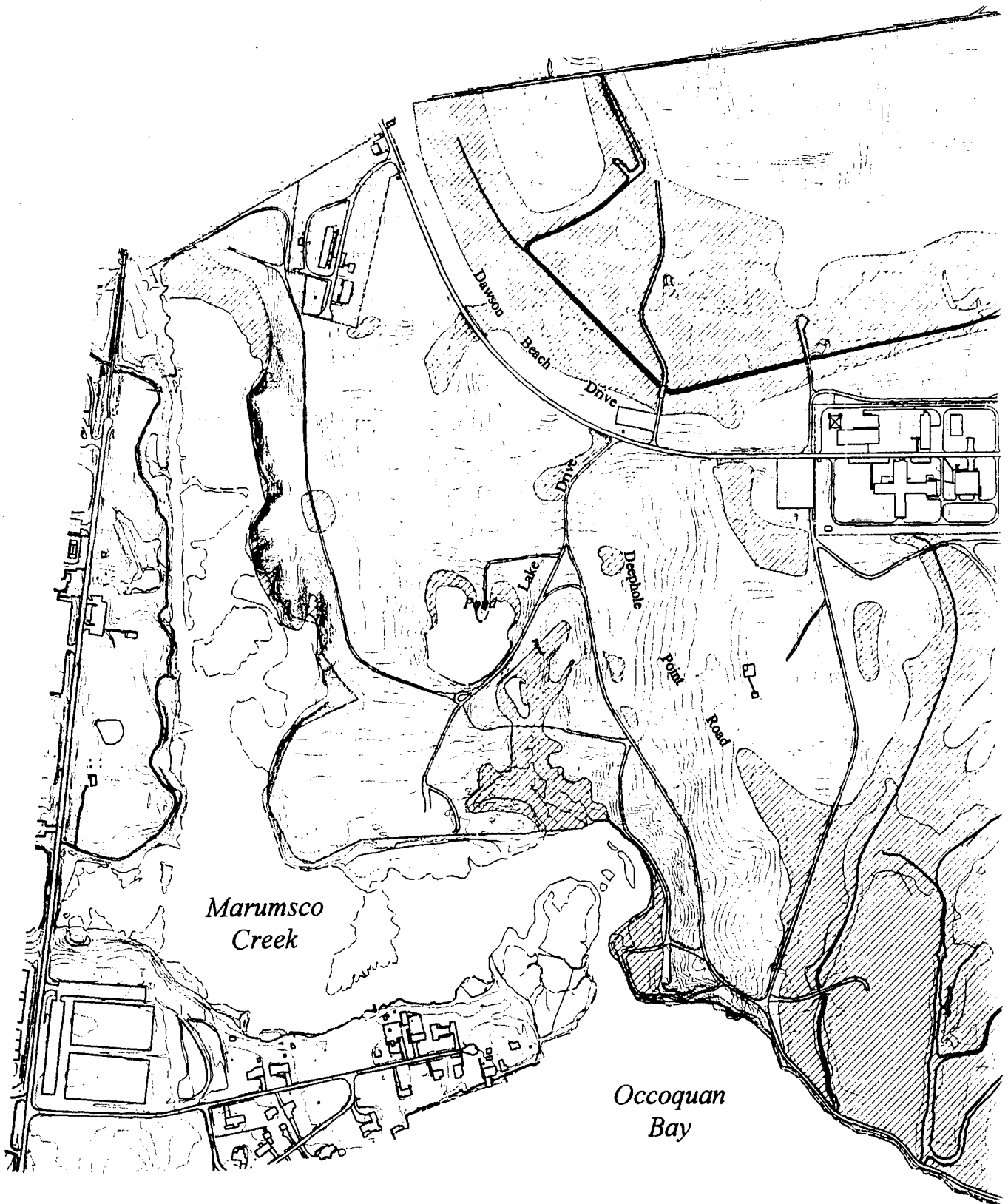
The level of data currently available for the site allows a reasonable estimate of the pattern of regional groundwater flow at the site. Water levels in the shallow aquifer system appear to be controlled by the nearby, local base level of Occoquan Bay, which is a regional discharge point for shallow groundwater. Groundwater moves radially from upland recharge areas north and northwest of the site toward Marumsco Creek, Occoquan Bay, and Belmont Bay.

The interaction between the Main Ditch and groundwater is difficult to assess with available well data. It is expected that over its course across the site property, the Main Ditch both loses and gains water depending on the underlying hydrogeologic unit and its degree of hydraulic connection with the Main Ditch. However, the composite water level map is drawn to show effluent conditions throughout its length to account for the possibility of shallow groundwater discharge from the subsurface to the ditch. There is a strong possibility, however, that in areas where the ditch flows across surface clay units, there is little interaction between groundwater and the ditch.



**Figure 4-1**  
**Woodbridge Wetland Areas**

# Woodbridge



# Wetland Areas

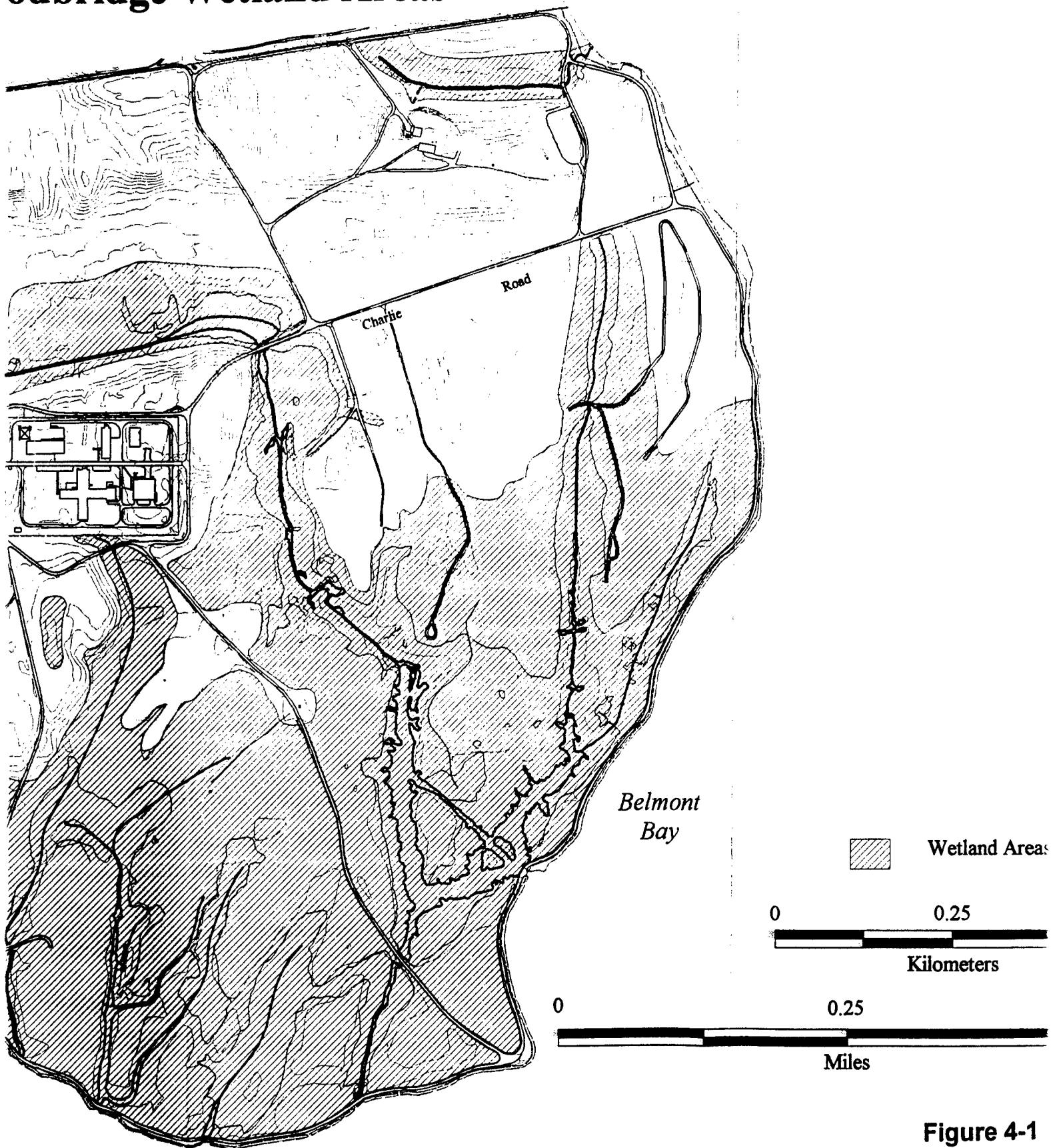
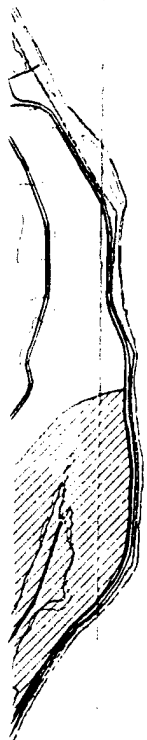
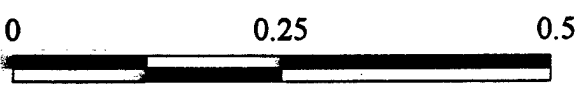


Figure 4-1



Wetland Areas



Kilometers



Miles

Figure 4-1

ICF040397003

3

**Section 5.0**  
**Previous Investigations**

## 5.0 PREVIOUS INVESTIGATIONS

This section summarizes the findings of previous investigations conducted at WRF. Section 5.1 includes a list of the previous investigations and the agency or contractor responsible for conducting the work. The previous investigations were grouped by OU and are consistent with the data presented in Section 6.0.

### 5.1 DESCRIPTION OF PREVIOUS INVESTIGATIONS

Previous investigations have been performed to evaluate the nature and extent of contamination at each of the AREEs within WRF. The previous investigations are described briefly below.

An RI was conducted by Environmental Science and Engineering, Inc., (ESE) in 1984 for USAEC. This remedial investigation consisted of the collection and analysis of soil, sediment and groundwater samples in the vicinity of OU1. This investigation led to a Removal Action for transformers, capacitors and contaminated soils in AREE 2. The Removal Action was conducted by Weston in 1985 and was followed by a five-year groundwater monitoring program.

A Site Investigation (SI) Phase I was performed by Earth Tech in 1993 for USAEC. This SI consisted of the collection and analysis of groundwater, surface water, soil, and sediment samples; geophysical surveys in some of the former dump areas; and construction of test pits in the areas where subsurface geophysical anomalies were detected. The locations of the trenches excavated for this SI are shown on Figure 5-1.

A Supplemental Site Investigation (SSI) Phase II was performed by Earth Tech in 1994 for USAEC. This work was completed to fill in data gaps realized during the review of the information gathered during the SI.

A Bioaccumulation Initiative was performed by the VADEQ in 1993. This initiative was conducted as part of the Virginia's Coastal Management Plan created by NOAA. The Bioaccumulation Initiative included the collection and analysis of soil, sediment, and storm water samples. Biota sampling was also conducted during this study. The report was published in 1994.

A Site Characterization (SC) Phase I of Building 202 Area was performed by Earth Tech in 1994 for USAEC. A Site Characterization Addendum (Phase II SC) was completed for the area around Building 202 was performed by Earth Tech in 1995. These investigations included the collection and analysis of soil, sediment and groundwater samples.

### 5.2 OU1 PREVIOUS INVESTIGATIONS

OU1 is comprised of the following eight AREEs: AREE 1 through AREE 6B (former open dumps) and AREE 7 (former pistol range). The locations of these AREEs are presented in Figure 2-4. Since 1984, OU1 has been the focus of several investigations.

#### 5.2.1 AREE 1 - Previous Investigations

Since 1984, several investigations have focused on AREE 1, a 0.4-acre former dump site in the southwest portion of WRF, bordered by Occoquan Bay to the south and Marumsco Creek to the west. The following sections present the results of previous investigations and Figure 5-2 presents the locations of samples collected during prior and current (RI) sampling events.

##### 5.2.1.1 *Environmental Science and Engineering, Inc., Remedial Investigation, 1984*

ESE collected soil and sediment samples and installed and sampled six monitoring wells, one upgradient from the former landfill (MW-7) and five downgradient from the former landfill (MW-8 through MW-12). Samples were analyzed for PCBs and PAHs.

*Summary of Results.* Low level PCB contamination was found in one soil sample (LF1S3), and polynuclear aromatic hydrocarbons (PAHs) were detected in a surface water sample (LF1W1). Periodic sampling of the monitoring wells from 1985 through 1990 detected PCBs with the highest concentration (2 µg/L) at MW-10. These results were later suspected to be unreliable and the monitoring program was terminated.

#### 5.2.1.2 USAEC Site Inspection, 1993 - 1994

The USAEC conducted an SI that included a geophysical survey to locate subsurface anomalies, a trenching program within suspected dumping areas to verify the existence of any subsurface anomalies, a soil sampling program from within the trenches where debris was encountered, and a groundwater sampling program from existing monitoring wells (USAEC, 1995c).

Summary of Results. Five anomalies were identified and four trenches were excavated (trenches 19 - 22) to investigate the anomalies. Debris was found in trenches 20 and 21 and one soil sample was collected from each trench (01EX0201 and 01EX0202) and analyzed for PCBs and pesticides. These samples contained PCB concentrations of 74 µg/g and 31 µg/g, respectively (USAEC, 1995c). The sample locations are presented on Figure 5-2.

No PCBs, pesticides, or volatile organic compounds (VOCs) were detected above method detection limits for groundwater (USAEC, 1995c).

#### 5.2.1.3 Virginia Department of Environmental Quality Bioaccumulation Initiative, 1994

In March, 1993, the VADEQ collected soil, sediment, and storm water samples at locations WRF03, WRF03A through WRF03H, WRF04, WRF04A through WRF04H, and WRF10. This sampling was conducted as part of Virginia's Coastal Zone Management Program (NOAA, 1994). The samples were analyzed for PCBs, PAHs, and pesticides.

Summary of Results. PCBs were detected in sediment, storm water, and surface soil at maximum concentrations of 0.034 µg/g (at WRF03E), 15 µg/L (at WRF03), and 1.1 µg/g (at WRF04F), respectively. Pesticides and PAHs were also detected in all media. The sample locations are presented on Figure 5-2.

Fish tissue sampling was also conducted during this study at sample location WRF03. Fillet and viscera were analyzed from bass, carp, catfish, herring, perch, gizzard shad, and sunfish. Chemicals of concern detected in these samples and their respective maximum concentrations of each chemical detected are as follows: PCBs (1500 µg/kg); benzo(a)pyrene (140 µg/kg); chlordane (24 µg/kg); 1,1-dichloro-2,2-bis(p-chlorophenyl)ethane (DDD) (27 µg/kg); 1,1-dichloro-2,2-bis(chlorophenyl)ethylene (DDE) (97 µg/kg); 1,1,1-trichloro-2,2-bis(chlorophenyl)ethane (DDT) (2 µg/kg); dieldrin (3 µg/kg); and endrin (29 µg/kg).

#### 5.2.2 AREE 2 and AREE 5 Previous Investigations

AREEs 2 and 5 are sites of former disposal areas where transformers (AREE 2), capacitors (AREE 2), and metal debris (AREE 5) were buried. These disposal areas are located adjacent to each other, just north of where Lake Drive dead ends, as shown in Figure 5-3. Due to the proximity of AREEs 2 and 5 to each other, they have been evaluated as a single source area. Therefore, current sampling locations, both upgradient and downgradient, encompass both AREEs. Results from previous site investigations related to AREEs 2 and 5 are presented below. Sample locations from past investigations, and this RI, are presented in Figure 5-3.

#### 5.2.2.1 Environmental Science and Engineering, Inc., Remedial Investigation, 1984

Surface soil and surface water samples were collected in 1984 as part of a RI (ESE, 1985). PCB-1016 was detected in surface soil samples at 2 µg/g (Landfill 2, No. 3, 330802) and 200 µg/g (Landfill 2, No. 6, 330805) and PCB-1260 was detected at 3 µg/g in Landfill 2, No. 6, 330805. Sample locations are presented in Figure 5-3 and are labeled as sample locations 3 and 6. Six monitoring wells were installed by ESE around AREE 2 in 1984, and a removal action was completed by Weston in 1985 to remove transformers, capacitors, and contaminated soil. A five-year groundwater sampling program was implemented from 1985 to 1990 to monitor PCB contamination. The PCB concentrations increased annually, with concentrations of up to 7 µg/L detected in samples collected from MW-2 and MW-3 (Weston, 1992). However, five of the six monitoring wells were sampled again by Earth Tech in 1993 as part of the USAEC SI, and no PCBs or VOCs were detected in the groundwater. Di-n-octylphthalate and bis(2-ethylhexyl)phthalate were detected at concentrations of 28 µg/L and 25 µg/L, respectively, in the groundwater sample collected from MW-2 (ESE, 1985). Di-n-octylphthalate and bis(2-

ethylhexyl)phthalate were detected at concentrations of 24 µg/L and 20 µg/L, respectively, in a surface water sample (Landfill 2, No. 7, 384102) collected from AREE 2 (ESE, 1985).

#### **5.2.2.2 USAEC Site Inspection, 1993 -1994**

USAEC conducted an SI that included a geophysical survey to locate subsurface anomalies; a trenching program within suspected dumping areas to verify the existence of any subsurface debris; a soil sampling program where debris was encountered within the trenches; and a groundwater sampling program from existing monitoring wells. Additionally, direct push groundwater samples, and surface water and sediment samples were collected at four locations (USAEC, 1995c).

Summary of Results. Two anomalies were identified, and three trenches (trenches 13 through 15) were excavated to investigate the anomalies. Debris was found in all three trenches, and one soil sample was collected from each trench and analyzed for PCBs, total petroleum hydrocarbon (TPH), and pesticides. PCBs, TPH, and pesticides were detected in soil samples collected from AREE 5 at maximum concentrations of 0.33 µg/g (05EX01), 35.1 µg/g (05EX01), and 0.043 µg/g (05EX02), respectively, and were collected during the same SI associated with AREE 2 (USAEC, 1995c).

PCBs were detected in one sediment sample collected during the 1993 SI near AREE 2 at a concentration of 0.07 µg/g. It should be noted that this sediment sample (02SE04) is located on the far side of a narrow peninsula and may be impacted more strongly by the Marumsco Creek than from surface water runoff from AREE 5 (USAEC, 1995c).

PCB-1254 was detected in a groundwater sample collected from direct push sample 05DP01 at a concentration of 0.14 µg/L (USAEC, 1995c).

#### **5.2.3 AREEs 3 and 6a Previous Investigations**

AREEs 3 and 6A are former dumps located in the northern portion of OU1, west of Deephole Point Road and east of Lake Drive. In past documents, these AREEs were treated separately. However, in view of their close proximity (40 feet) to each other (an ephemeral pond separates the two), these two AREEs have been grouped together, and the ephemeral pond has been included in the following discussion.

AREE 3 is approximately located just east of the ephemeral pond on the east side of Lake Drive and is thought to be approximately 100 feet by 25 feet. The burial of debris such as wood, lead-coated wire, paper, and plastic reportedly began in 1966, and continued until this area was covered with soil in 1973 (Weston, 1992). AREE 6A is located west of Deephole Point Road and south of Lake Drive. This dump was identified by ground scars and soil disturbances observed in aerial photographs, and metal debris has been observed protruding from the toe of the slope along the southwestern extent of AREE 6A. The following sections present data derived from previous investigations focusing on AREEs 3 and 6A. Figure 5-4 presents previous and current sampling locations for these AREEs.

##### **5.2.3.1 USAEC Site Inspection, 1993 - 1994**

The USAEC conducted an SI that included a geophysical survey to locate subsurface anomalies, a trenching program within suspected dumping areas to verify the existence of any subsurface debris, and a soil sampling program where debris was encountered within the trenches. Additionally, direct push groundwater samples were collected from the area (USAEC, 1995c).

Summary of Results. Three anomalies were identified in AREE 3, and three trenches were excavated (trenches 10 through 12) to investigate the anomalies. Debris was found in trench 12, and one soil sample (03EX0101) was collected from within the trench. The sample was analyzed for PCBs and pesticides. No PCBs or pesticides were detected above method detection limits (USAEC, 1995b).

Three anomalies were identified in AREE 6A by the geophysical survey, and four trenches (trenches 1 through 4) were excavated to investigate the anomalies. Debris was found in trenches 1, 2, and 4. Soil samples were collected from trenches 1 and 2 (6AEX0101 and



6AEX0201) and analyzed for PCBs and pesticides. Pesticides and PCBs were not detected in these soil samples (USAEC, 1995c). Trench locations are shown on Figure 5-1.

Direct push groundwater samples were collected from AREE 3 and acetone was detected in groundwater at a concentration of 18 µg/L (03DP02). A total of five direct push samples (6ADP01A, 6ADP01B, 6ADP01C, 6ADP02, and 6ADP03) were collected from within AREE 6A during this investigation. However, only one (6ADP03) was submitted for pesticide/PCB analysis. Pesticides/PCBs were not detected above method detection limits in 6ADP03 (USAEC, 1995b).

PCBs were detected in sediment samples collected during the 1993 SI near AREE 3 at concentrations of 0.014 µg/g in 02SE01 (located upgradient from AREE 3 in the pond adjacent to PZ-12) and 02SE02 (located downgradient of AREES 3 and 6A). A PCB concentration of 0.13 µg/g was detected in 02SE02 (USAEC, 1995c).

#### **5.2.4 AREE 4 Previous Investigations**

AREE 4 is a former dump site where debris, such as wire, wood, concrete, pipe insulation, and empty oil drums, was dumped from the late 1950s until 1973 when the dump was covered with dirt (Weston, 1992).

##### **5.2.4.1 USAEC Site Investigation, 1993 - 1994**

USAEC conducted an SI that included a geophysical survey to locate subsurface anomalies, a trenching program within suspected dumping areas to verify the existence of any subsurface anomalies, and a soil sampling program where debris was encountered within the trenches. Additionally, direct push groundwater samples were collected from this location.

Summary of Results. Numerous anomalies were identified by the geophysical survey and five trenches (trenches 5 through 9) were excavated to investigate the anomalies. Debris was found in trenches 6 and 7 and one soil sample (04EX0101) was collected from trench 7. The sample was analyzed for PCBs, pesticides, VOCs, and TPH. PCBs and TPH were detected at concentrations of 0.85 µg/g and 220.7 µg/g in this sample (USAEC, 1995c). The sample locations from past investigations, and this RI, are presented in Figure 5-3.

Five direct push groundwater sampling points (04DP01A, 04DP01B, 04DP01C, 04DP02, and 04DP03) were attempted during this investigation. However, only one sample (04DP03) was collected. This sample was analyzed for VOCs and pesticides/PCBs. VOCs and pesticides/PCBs were not present above detection limits in the deep push groundwater sample.

#### **5.2.5 AREE 6B Previous Investigations**

AREE 6B is a former dump located at the intersection of Deephole Point Road and Shady Road across from AREE 1. It was identified based on ground scars and soil disturbances illustrated on aerial photographs for the facility taken in the 1960s and 1970s which were reviewed during the Preliminary Assessment (USAEC, 1995e).

##### **5.2.5.1 USAEC Site Investigation, 1993 - 1994**

USAEC conducted a SI that included a geophysical survey to locate subsurface anomalies, a trenching program within suspected dumping areas to verify the existence of any subsurface debris, and a soil sampling program where debris was encountered within the trenches. Additionally, direct push groundwater samples were collected from this location.

Summary of Results. Two anomalies were identified by the geophysical survey, and three trenches (trenches 16 through 18) were excavated to investigate the anomalies. Debris was not found in any of the trenches. No soil samples were collected (USAEC, 1995c). A supplemental investigation of the AREE was conducted and a soil boring was drilled and sampled. Sample locations from previous (and current RI) investigations are presented in Figure 5-5.

TPH was detected in soil samples collected from soil boring 06BH01 at depths of 0.5 to 1.5 feet bgs and 4.5 to 5.5 feet bgs at concentrations of 28 µg/g and 61.4 µg/g, respectively (USAEC, 1995c).

### 5.2.6 AREE 7 (Former Pistol Range) Investigations

AREE 7 is a former pistol range located at the intersection of Deephole Point Road and Shady Lane. The range was used for small arms firing on a semi-annual basis during the 1970's.

#### 5.2.6.1 USAEC Site Investigation, 1993 - 1994

After site reconnaissance, a 5 foot by 5 foot area was excavated to a depth of 5 feet and a subsurface soil investigation and a soil boring sampling program was implemented. The soil samples were collected and analyzed for metals (USAEC, 1995c).

Summary of Results. The soil sample (7EX0101) collected from the excavation contained concentrations of aluminum, beryllium, calcium, chromium, cobalt, copper, lead, manganese, nickel, potassium, sodium, vanadium, and zinc above background levels. One spent bullet was found in soil boring 07BH01 at a depth of 1.5 feet bgs and one shell casing was found in borehole 07BH04 at an approximate depth of 1 foot bgs. The analytes aluminum, arsenic, barium, beryllium, calcium, chromium, cobalt, copper, lead, magnesium, manganese, nickel, potassium, sodium, vanadium, and zinc were detected in concentrations above background levels (USAEC, 1995c). The former SI sample locations from the SI and surface soil sample locations for this RI are presented on Figure 5-5.

## 5.3 OU2 PREVIOUS INVESTIGATIONS

OU2 (Main Facility Compound) contains AREEs 8; 10; the portion of AREE 11 that is within the fenced area; AREEs 12 through 16; the portion of AREE 17 that is within the fenced area; AREE 18 through 21; and AREEs 23b; 23c; 24a; 24b; 24c; 24d; 28; 31; 32; and 40. Contaminated media have been identified at many of these AREEs during previous investigations.

### 5.3.1 OU2 - Main Facility Compound

OU2 contains 14 AREEs which are located within the Main Facility Compound or adjacent to it (AREE 11 which includes the former PCB Hot Spot area). Results of previous investigations are presented below in numerical order for each of the AREEs.

#### 5.3.2 AREEs Associated with Building 202 Drainage Devices (AREEs 8, 11, 12, and 17)

AREEs 8, 11, 12, and 17 have been presented together in this section because of their proximity to one another. In addition, sampling performed for the RI was designed to investigate this area collectively to evaluate the nature and extent of the potential impacts from runoff and contamination downgradient from these AREEs.

AREE 8 is the site of three former 10,000-gallon steel underground storage tanks (USTs) where diesel fuel and No. 2 fuel oil were stored from 1966 until they were removed. The fuel tanks were located on the east side of Building 202. One tank was removed in 1981 and replaced with a 2,000-gallon fiberglass underground storage tank (UST) (which is now AREE 24a). The remaining two tanks were removed in 1990. It should be noted that AREE 24a (2,000-gallon fiberglass UST) previously referred to as an "existing 2,000-gallon UST" was removed in November 1996 and is now referred to as "former 2,000-gallon fiberglass UST".

AREE 11 includes the former oil/water separator and former vehicle wash rack which were located to the north of Building 202. This AREE also includes storm lines and drainage devices for the area north of Building 202.

AREE 12 is a former drum storage area located adjacent to the north side of Building 202 where the WRF maintenance facility and vehicle repair facility were located. A wide range of organic and inorganic compounds, as well as products from Building 202, were temporarily placed in drums and stored on the pavement in this area. There are no records of releases, but the paved area contains

patches of worn and discolored asphalt. Drainage from this area was toward the former oil/water separator (AREE 11).

AREE 17 is the site of an April 1989 hydraulic oil spill where approximately 100 to 150 gallons of No. 2 hydraulic oil leaked onto the soil. Approximately 40 to 60 tons of contaminated soil were removed after the spill, and the soil was incinerated. The spill was located northwest of Building 202 and just west of the antenna tower. The sample locations for these four AREEs are shown in Figure 5-6.

### 5.3.2.1 Results of Previous Investigations

The three former 10,000-gallon USTs (AREE 8) were investigated during Phase I of the SI. This investigation included the excavation of two trenches located in the former USTs area. Discolored soils were identified and the soils were screened using a Photoionization Detector (PID). The maximum PID level was 13 parts per million (ppm). Soil samples (23EX0101, 23EX0102, and 23EX0201) were collected from the trenches at approximately 7 feet bgs. In addition, two composite surface soil samples (08SS0101 and 08SS0102) were collected in the area of a reported spill at the former USTs (USAEC, 1995a). Two existing monitoring wells, MW-13 and MW-14, were also sampled. All samples were analyzed for TPH. Prior sampling locations are presented in Figure 5-6.

Surface soil samples contained TPH but were below the VADEQ regulatory action level (100  $\mu\text{g/g}$ ) and ranged from 14  $\mu\text{g/g}$  to 42  $\mu\text{g/g}$ . The trench samples contained TPH at concentrations of 209  $\mu\text{g/g}$ , 302  $\mu\text{g/g}$ , and 30  $\mu\text{g/g}$  in samples 23EX0101, 23EX0102, and 23EX0201, respectively. The TPH concentration detected in the groundwater sample collected from MW-13 was the same as the detection limit of 1  $\mu\text{g/L}$ . TPH was not detected in the sample collected from MW-14.

During Phase I of the SI, five monitoring wells/soil borings (MW-31, MW-32S, MW-32D, MW-33, and MW-34) were installed and three soil borings (A08-1, A08-3, and A08-4) were completed in the former 10,000-gallon USTs area. One soil sample was collected from each of the monitoring well/soil boring locations from 8 to 10 feet bgs, except MW-32S. No soil samples were collected from MW-32S and two soil samples were collected from MW-32D at 6 to 8 feet bgs and 10 to 12 feet bgs. Two soil samples each were collected from A08-1 and A08-3 at 4 to 6 feet bgs and 8 to 10 feet bgs. One soil sample was collected from A08-4 from 2 to 4 feet bgs. Soil samples collected from these borings were analyzed for TPH, benzene, toluene, ethylbenzene, and xylene (BTEX), pesticides/PCBs, and lead (USAEC, 1995b). During Phase II of the SI, seven additional borings (A08-5 through A08-9, BH-35 and BH-36) were also completed. Two of the borings (BH-35 and BH-36) were converted to monitoring wells (MW-35 and MW-36). One soil sample was collected from each of these borings from 5 to 10 feet bgs. Soil samples collected from these borings were analyzed for VOCs, semivolatile organic compounds (SVOCs), TPH, pesticides/PCBs, and metals. Groundwater samples collected from MW-35 and MW-36 were sampled and analyzed for VOCs, SVOCs, TPH, PCB/pesticides, and metals. Monitoring wells MW-31 through MW-34 analyzed for TPH, BTEX, and lead (USAEC, 1995b). Prior sampling locations are presented in Figure 5-5.

The soil investigation results showed TPH contamination above the VADEQ action level (100  $\mu\text{g/g}$ ) within and immediately adjacent to the former UST trenches. Soil boring BH-32D contained the highest TPH concentrations at 149  $\mu\text{g/g}$  (10 to 12 feet bgs) to 2,166  $\mu\text{g/g}$  (6 to 8 feet bgs). TPH was detected at a concentration of 143  $\mu\text{g/g}$  in boring A08-9 and concentrations ranged from 209  $\mu\text{g/g}$  to 302  $\mu\text{g/g}$  in the trench excavation soil samples. TPH was detected at a concentration of 109  $\mu\text{g/g}$  in the sample collected from 4 to 6 feet bgs in a downgradient borehole (A08-3), located at a surface water drainage culvert. No significant amounts of contamination were detected in the groundwater samples (USAEC, 1995b). Locations of prior sampling points are presented in Figure 5-6.

The former oil/water separator (AREE 11) was investigated by Earth Tech during the 1993 SI (USAEC, 1995a). Limited excavation was performed around the oil/water separator during which discolored soil exhibiting petroleum odors was observed. However, no leaks were detected upon examination of the oil/water separator. Two soil samples were collected during the excavation and analyzed for VOCs, SVOCs, and TPH. These soil samples contained low levels of SVOCs and TPH, ranging in concentration from 145  $\mu\text{g/g}$  (11EX0103) to 4,937  $\mu\text{g/g}$  (11EX0102). One surface water sample and one sediment sample (11SW01/11SE01) was collected from the separator outfall. In addition, one aqueous sample (11AQ01) was collected from inside the separator. The aqueous samples

were analyzed for VOCs and SVOCs. The sediment sample was analyzed for VOCs, SVOCs, TPH, and pesticides/PCBs. No significant concentrations of these compounds were detected in the aqueous samples.

A removal action was initiated in the summer of 1995 in which the oil/water separator, washrack, soils around the excavated pits, and contaminated soils along the outfall ditch were removed. An illustration of the ditch excavation area is presented in Figure 5-6. During the removal action excavation, a water-bearing sand lens exhibiting a visible oil sheen was encountered. A water sample was collected from this zone and analyzed for PCBs and TPH. PCBs were detected at a concentration of 6.4 µg/L and the estimated TPH concentration was 220 µg/L (USAEC, 1995d). A pre-excavation soil sample was collected from the trench area and was analyzed for PCBs. The maximum PCB concentration was 16,000 µg/g (Waltemyer, 1995). Soil samples were collected from the excavation during the removal action. PCBs were detected in soil samples collected from the sidewall of the excavation at levels as high as 210 µg/g (USAEC, 1995d). Hydropunch® samples were collected in downgradient locations to determine the extent of TPH contamination in groundwater. The Hydropunch® sample locations are not presented because the exact locations are not known. TPH was detected in all downgradient locations investigated, including the Main Drainage Ditch (AREE 22). The extent of the contamination was not determined. The suspected source areas for the TPH contamination are the former USTs located on the east side of Building 202, the former washrack area, the former UST located on the north side of Building 202 (AREE 23b), and possibly the former UST located on the east side of Building 203 (AREE 24c). The likely PCB source areas are the former oil/water separator and the former washrack.

The drum storage area (AREE 12) was investigated during Phase I of the SI. Composite surface soil samples (12EX0101 and 12EX0102) were collected from soils immediately below the paved area at this location and analyzed for TPH, VOCs, and SVOCs. During Phase II of the SI, four soil borings (12BH01 through 12BH04) were drilled and subsurface soil samples were collected to depths of 10 feet bgs. Subsurface soil samples were analyzed for VOCs, SVOCs, TPH, pesticides/PCBs, and metals. Acetone, 2-butanone, and TPH were detected in the shallow composite soil samples (12EX0101 and 12EX0102) at maximum concentrations of 0.100 µg/g, 0.012 µg/g, and 66.3 µg/g, respectively. Di-n-octylphthalate was detected in three soil boring samples at a maximum detected concentration of 0.270 µg/g (USAEC, 1995a). Manganese was detected in one soil boring sample slightly above the residential RBC (390 µg/g) at a concentration of 410 µg/g. Cyanide was detected at a concentration of 2.61 µg/g in one soil sample (USAEC, 1995a). Two additional soil borings (A08-7 and A08-8) were drilled in the area during Phase II of the SC. Samples were collected at 5 and 9 feet bgs and analyzed for VOCs, SVOCs, TPH, PCBs/pesticides, and metals. Organics detected in these samples were below residential RBCs and inorganics detected were below background values (USAEC, 1995b). Sampling locations are presented in Figure 5-6.

AREE 17 (1989 hydraulic fuel spill area) was investigated during Phase II of the SI. Three surface soil samples (17SS0101, 17SS0201, and 17SS0301) were collected approximately 100 feet north of the antenna tower, in an area where stressed vegetation was identified. The soil samples were analyzed for VOCs, base neutral/acid-extractable compounds (BNAs), TPH, pesticides/PCBs, and metals. Dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene were detected above their respective residential RBCs (USAEC, 1996a). Sampling locations are presented in Figure 5-6.

### 5.3.3 AREE 10 - Sump in Building 202

AREE 10 is defined as the sump and related drainage lines located in the southeast corner of Building 202 (Figure 5-5). Prior to 1971, Building 202 housed a number of electrical generators. Since 1971, activities routinely performed in the maintenance shop included vehicle maintenance, carpentry, and minor electrical repairs. Containers of unused oil and waste oil, cleaning solvent, paint, paint thinner, and battery acid were stored in the building. Water and petroleum products were reported to have been observed in the sump in the past. The sump houses the condensate return tank and a sump pump which discharges via an underground conduit to a culvert northeast of Building 202. The sump is constructed of cinder block and is approximately 4 feet square by 10 feet deep (USAEC, 1995b).

A water sample (23AQ01) was collected from the sump during the 1993 Phase I SI and analyzed for TPH. An additional water sample (08AQ01) was collected from the sump for Phase I of the SC and

analyzed for BTEX, TPH, and lead. Three boreholes (A08-1, A08-3, and A08-4) were drilled along the sump pump drainage line during Phase I of the SC and two boreholes (A08-6 and BH-36) were also drilled inside Building 202 during Phase II of the SC. One subsurface soil sample was collected from each boring and two subsurface soil samples were collected from A08-1. BH-36 was converted into monitoring well MW-36. (USAEC, 1995b). Soil and groundwater samples were analyzed for VOCs, SVOCs, TPH, pesticides/PCBs, and metals. Sample locations are presented in Figure 5-6.

The water sample 23AQ01 and its duplicate, collected during the Phase I SI, contained TPH concentrations at 2 µg/L and 84 µg/L, respectively. Samples collected from the sump during Phase I of the SC did not contain TPH, BTEX, or dissolved lead above the detection limits. It was concluded that TPH present in the initial samples were a result of floating residual oil from the Building 202 floor drainage (USAEC, 1995b). Neither TPH, BTEX, nor lead were detected in soil samples collected from boreholes A08-1 and A08-4. TPH was detected in the sample collected from borehole A08-3 from 4-6 feet bgs at a concentration of 109 µg/g, but was not detected in the sample collected from 8-10 feet bgs. No significant concentrations of TPH were detected in the soil or groundwater samples collected within Building 202 (A08-6 and MW-36), adjacent to the sump. Therefore, the shallow TPH concentrations are likely due to former sump-pump discharge or storm water containing residual TPH from area runoff (USAEC, 1995b).

#### 5.3.4 AREE 13 – Former Acid Neutralization Tank

AREE 13 is a 1,000-gallon concrete underground neutralization tank located west of Building 211 (Figure 5-6). This tank was installed in 1979 during the construction of Building 211 and removed in November, 1996. It received drainage from a lead-acid battery storage and recharging room located within the building. Reportedly, a contractor would flush the tank twice a year with water and add limestone to the tank, but no evidence is available to prove that this activity occurred (USAEC, 1995a). The device was removed in November, 1996.

During Phase I of the SI, the soils adjacent to the tank were excavated to 10 feet bgs on the western side and 4 feet bgs on the northern side. The bottom of the tank was located at approximately 6 feet bgs. No leaks or stained soil were observed during excavation and the soil pH averaged about 6.4 throughout the excavation. Upon inspection, the tank was found to be structurally sound. A soil sample (13EX01) was collected from the excavation at 10 feet bgs for confirmatory analytical analysis for pH. The results showed the soil to have a pH of 6.5.

During Phase II of the SI, three boreholes (13BH01, 13BH02, and 13BH03) were hand augured adjacent to the tank to a depth of approximately 8 feet bgs. Soil samples were collected from each borehole at 6 feet bgs and analyzed for inorganics. The results indicated that the soils surrounding the tank were not contaminated (USAEC, 1995a). Sampling locations are presented in Figure 5-7.

#### 5.3.5 AREE 14 - Former Oil/Water Separator

AREE 14 is the former oil/water separator located adjacent to the north side of Building 211 (Figure 2-5). The separator received drainage from the work area inside Building 211 and discharged to the grassy area east of the Main Facility Compound. There have been no spills reported from the work areas inside Building 211 and no significant amounts of hazardous liquids are believed to have been stored or handled in this area (USAEC, 1996a).

During the 1993 SI, soils adjacent to the separator were excavated and no odors or discolored soils were observed. Two soil samples (14EX0101 and 14EX0102) from the excavation and two sediment samples with a duplicate (14SE01) from the outfall were collected and analyzed for TPH, VOCs, and SVOCs. A surface water sample with a duplicate (14SW01) from the outfall and an aqueous sample (14AQ01) from the separator were collected and analyzed for VOCs and SVOCs. Trace amounts of phthalates were detected in surface water samples collected from the outfall. Only one compound, bis(2-ethylhexyl)phthalate, was detected above the RBC (4.8 µg/L) in 14SW01 at a concentration of 1,000 µg/L. TPH was detected in the soil samples and sediment samples ranging in concentrations from 51 µg/g to 65 µg/g, which are below the 100 µg/g Virginia UST Program Action Level for TPH in soil (USAEC, 1995a).

In order to determine if the phthalates detected were of concern, a soil and a groundwater sample were collected during the Phase II SSI from a newly installed monitoring well (MW-41). Both samples were analyzed for VOCs, BNAs, pesticides/PCBs, TPH, and metals. No significant amounts of contamination were detected (USAEC, 1996a). Sample locations from previous investigations are presented in Figure 5-7.

### 5.3.6 AREE 15 - Building 201 PCB Transformer

In July and August of 1990 all WRF power distribution transformers were tested. The transformer adjacent to Building 201 was the only transformer found to contain PCBs (Figure 2-5). The transformer contained 565,800 µg/g of PCB-1260. In December 1992, the transformer and its concrete pad were replaced with a PCB free transformer and a new concrete pad (USAEC, 1996a).

PCB soil screening samples were collected during Phase I of the SI and the results were positive. During Phase II of the SI, one surface soil sample (15SS0101) was collected and analyzed for VOCs, BNAs, pesticides/PCBs, TPH, and metals. Benzo(a)pyrene was detected above the residential RBC (0.088 µg/g) at a concentration of 0.221 µg/g. PCBs were not detected (USAEC, 1996a). The sample location is presented in Figure 5-7.

### 5.3.7 AREE 16 Asbestos Containing Material

Asbestos-containing material (ACM) is suspected to remain in the floor tiles located throughout the facility. Historically, ACM has been removed when encountered during the course of routine heating system repairs and upgrades.

An Asbestos Location Survey of WRF was recently completed and floor tiles in certain buildings were identified as containing asbestos as well as small amounts left adhering to ductwork. AREE 16 was not investigated during this RI.

### 5.3.8 AREES 18 and 19 - Flammable/Battery Storage (Building 204)

AREE 18 is the Flammable/Battery Storage Building 204 (Figure 2-5). Building 204 is a small two room structure with a concrete floor. Flammable materials were stored in one room and vehicle batteries were stored in the other. The battery room has a safety shower with a drain. An acid spill could potentially flow into the drain and be discharged into the gravel pit located east of the building. AREE 19 is defined as this discharge area outside of Building 204 (Figure 2-5).

During the Phase I of the SI, an excavation was performed to expose the outfall of the drain pipe from Building 204. The drain pipe terminated at an underground gravel sump at an approximate depth of 3 feet bgs just east of Building 204. No stained soil or liquids were found. Three surface soil samples and one subsurface soil sample (18SS01 through 18SS03, and 18EX01) were collected at the drain outfall and analyzed for VOCs, SVOCs, and metals (USAEC, 1995a). Toluene was detected in 18SS01 at 0.0031 µg/g. No other organics were detected and inorganic results did not indicate significant contamination.

During the Phase II SI, samples of the Building 204 joint material (18SD0101 and 18SD0102) which connects the floor to the wall were collected and analyzed for VOCs and SVOCs. A number of inorganic and organic compounds were detected in these samples. Also, two subsurface soil samples (18SS04 and 18SS05) were collected from beneath Building 204 concrete floor during the Phase II SI to evaluate if battery acid spills have impacted the soils. Samples were analyzed for VOCs, BNAs, pesticides/PCBs, TPH, and metals. No organic compounds were detected. Aluminum, arsenic, beryllium, iron, and manganese were detected above residential RBCs in these samples. Sampling locations are presented in Figure 5-7.

### 5.3.9 AREE 20 - Former Incinerator

AREE 20 has been designated as the former incinerator which was located in the Main Facility Compound. The location of AREE 20 is presented on Figure 2-5. The incinerator was used from the 1950's until 1970. Ash was periodically removed from the stack, drummed, and disposed of in one of the on-site landfills. The incinerator was dismantled in 1972 and disposed of in AREE 1 (USAEC, 1996a).

A shallow area within AREE 20 was excavated during Phase I of the SI to evaluate soil conditions. No samples were collected because no evidence of contamination (stained soils) was observed (USAEC, 1996a).

This area was investigated again during Phase II of the SI. Four surface soil samples (20SS0101 through 20SS0401) were collected and analyzed for TCL VOCs, BNAs, pesticides/PCBs, TPH, dioxin, and Target Analyte List (TAL) metals. Organic concentrations were not detected above residential RBCs. Arsenic, beryllium, iron, and mercury (at a concentration of 9.5 µg/g) were detected above RBCs, but migration potential was considered low due to vegetative coverage (USAEC, 1996a). Sample locations are presented on Figure 5-7.

### 5.3.10 AREE 21 - Former Storage Area

AREE 21 is located east of Building 211 and was used as a storage yard prior to the construction of Building 211 in 1979 (Figure 2-5). Transformers and capacitors containing PCBs were stored in this area prior to their disposal.

During Phase I of the SI, four surface soil samples (21SS01 through 21SS04) were collected and analyzed for TPH and pesticides/PCBs. TPH was detected in all four samples at concentrations ranging from 30 to 55 µg/g. These concentrations are all below the 100 µg/g VADEQ UST Program Action Level for TPH in soil (USAEC, 1995a).

Four boreholes (21BH01 through 21BH04) were drilled during Phase II of the SI. Subsurface soil samples were collected from 2 to 4 feet bgs and 8 to 10 feet bgs and analyzed for TPH, VOCs, SVOCs, and pesticides/PCBs. Di-n-octyl phthalate was detected slightly above the detection limit at a concentration of 0.23 µg/g in one sample collected from a depth of 2-4 feet bgs (USAEC, 1995a).

Six PCB soil screening samples were collected during the Phase II SSI. PCBs were detected in two of the screening level soil samples. These detections prompted four additional screening level samples to be collected from the same locations. Each of the additional samples tested negative for PCBs. A surface soil sample (21SS05) was collected and analyzed in the laboratory for VOCs, BNAs, pesticides/PCBs, TPH, and metals. Organics were not detected and no elevated levels of inorganics were detected (USAEC, 1996). Sample locations are presented on Figure 5-7.

### 5.3.11 AREE 23b Former 1,000-Gallon UST

AREE 23b is the site of a former 1,000-gallon steel UST located north of Building 202, which was used to store gasoline (refer to Figure 5-6 for location). In 1990, the tank was removed and replaced with a 1,000-gallon fiberglass tank. Two monitoring wells (MW-13 and MW-14) were installed along the perimeter of the former tank area to evaluate the extent of petroleum contamination. This AREE is being investigated under the State of Virginia UST program.

AREE 23b was investigated during Phase I and II of the SC. Two borings (A23-1 and A23-2) were advanced adjacent to the UST area during Phase I of the SC. Soil samples were analyzed for TPH, BTEX, pesticides/PCBs, and lead. Two borings (BH-37 and BH-38) were advanced adjacent to the UST during Phase II of the SC and analyzed for VOCs, SVOCs, TPH, pesticides/PCBs and metals. These two borings were converted to monitoring wells (MW-37 and MW-38) and groundwater samples were collected and analyzed for VOCs, SVOCs, TPH, pesticides/PCBs, and metals (USAEC, 1995b).

TPH was detected in A23-1, A23-2, BH-37, and BH-38 at concentrations of 353 µg/g, 75 µg/g, 159 µg/g, and 82 µg/g, respectively. No other significant organic concentrations were detected. No compounds were detected above residential RBCs in the groundwater samples collected from monitoring wells MW-37 and MW-38 (USAEC, 1995b).

### 5.3.12 AREE 23c - Former UST

AREE 23c has been designated as the former 2,000-gallon steel UST located east of Building 203 (Figure 2-5). The UST was installed in 1966 and was used to store #2 fuel oil. The tank was removed in 1986 or 1987 with no record of leak testing or soil analyses. Surface soil samples collected at AREE 23c during the 1993 SI contained 30 µg/g of TPH. This AREE was not investigated during this RI.

### 5.3.13 AREEs 24a and 24b - Former USTs

AREEs 24a and 24b (AREE 24b is geographically co-located with AREE 23b) are former 2,000-gallon and 1,000-gallon capacity USTs, respectively, that were previously used for diesel fuel (24a) and gasoline storage (24b). The location of AREEs 24a and 24b are presented on Figure 2-5. Both USTs were removed in November 1996. During removal, excavated soils appeared to be clean with no evidence of tank failure. Soil samples were collected when the tank was excavated. TPH was detected at a concentration of 64.7 mg/kg as reported in the tank closure document. It was later determined that this soil was suitable to use as backfill for the excavation and was subsequently placed back in the excavated pit (Craig, 1997).

### 5.3.14 AREEs 24c and 24d - Former USTs

AREEs 24c and 24d are the sites of former 10,000-gallon and 1,500-gallon USTs previously used to store No. 2 fuel oil. The 10,000-gallon UST was removed in November 1996. It was located along the eastern side of Building 203 as shown in Figure 2-5. Petroleum contamination was evident on the manway, but excavated soils appeared to be clean with no evidence of tank failure. Soil samples were collected when the tank was excavated. TPH was detected at a concentration of 183 mg/Kg as reported in the tank closure document. The 1,500-gallon UST was located north of Building 211. The 1,500-gallon UST was removed in December 1996 with no evidence of contaminated soils found during tank removal. Soil samples were collected when the tank was excavated. TPH was detected at a concentration of 13.5 mg/Kg as reported in the tank closure document. It was later determined that this soil was suitable to use as backfill for each of the excavations and was subsequently placed back in the excavated pits (Craig, 1997). The VADEQ NRO has now required that three monitoring wells be installed and a site characterization be submitted.

### 5.3.15 AREE 28 - Radon

Under the direction of ARLs Industrial Hygienist, an installation-wide survey was performed during 1993. Radon detection canisters were left in place to collect air samples at strategic locations throughout the facility for a six month period. The highest level of radon detected in the field was well below USEPA's recommended 4.0 picocuries per liter (pCi/L) threshold level for corrective action.

### 5.3.16 AREE 31 - Low Level Radioactive Material Usage and Storage

Low level radioactive material was used for research and development purposes since the 1980s. There is no evidence that any of these sealed sources were ever damaged or ruptured. The U.S. Army's Center for Health Promotion and Preventative Medicine was tasked by ARL to perform a comprehensive records search to determine if licensed radioactive commodity items were ever utilized at WRF during the period of 1951 through 1971, and to provide explicate guidance to ARL as to the appropriate actions necessary to close out this AREE. A Close-Out Survey Report was published in April 1997, and AREE 31 has been recommended for release for unrestricted reuse.

### 5.3.17 AREE 32 - Lead Paint

This AREE was created in 1994 for administrative purposes only. The USAEC has determined that a Lead Paint Survey is presently not necessary because it does not appear that the United States Fish and Wildlife Service will be utilizing the buildings for residential purposes. This AREE was not investigated during the RI.

### 5.3.18 AREE 40 - Former Water Tower

AREE 40 was established by the Base Closure Team (BCT) in February 1995 based on concerns that lead contamination from paint stripping activities has been associated with water towers at other facilities (USAEC, 1996b).

This AREE was investigated during Phase II of the SSI. One surface soil sample (40SS0101) was collected and analyzed for TCL VOCs, BNAs, pesticides/PCBs, TPH, and TAL metals. Lead was detected at 1,450 µg/g, which is significantly higher than the action level for lead (400 µg/g) as defined by USEPA Revised Interim Soil Lead Guidance for CERCLA and Resource Conservation Recovery Act (RCRA) Corrective Action Facilities (OWSER Directive 9355.4-12). DDT and DDE were detected at



concentrations of 0.0425 µg/g and 0.114 µg/g respectively, which is below their RBCs of 1.9 µg/g. Additional organic compounds were not detected (USAEC, 1996a). The sample location is presented in Figure 5-7.

## 5.4 OU3 PREVIOUS INVESTIGATIONS

This section summarizes the results from previous investigations focusing on OU3, (the Main Ditch, north of Charlie Road, the portions of AREE 11 and AREE 17 which are outside and north of the fence surrounding the Main Compound Area). The area of the ditch directly north of the Main Facility Compound received runoff from the former oil/water separator and the former washrack, and PCBs are the primary chemical of concern. The upper-most reaches of the drainage ditch have received runoff from on-site and off-site sources.

### 5.4.1 Virginia Department of Environment, Bioaccumulation Initiative

In March 1993, the VADEQ collected sediment and storm water runoff samples from the portion of the ditch which is topographically downgradient from the Main Facility Compound (which includes runoff from the former oil/water separator and former washrack). This sampling was done as part of Virginia's Coastal Zone Management Program (NOAA, 1994). The sample locations are presented in Figure 5-8. The samples were analyzed for TCLCompound List (TCL), VOCsorganic compounds (VOCs), TCL SVOCsorganic compounds (SVOCs), PCBs/pesticides, and TALAnalyte List (TAL) metals.

#### 5.4.1.1 Summary of Results

PCB-1260 was detected in the sediment and storm water runoff samples. The concentration of PCB-1260 in sediments ranged from 4.8 µg/g to 100 µg/g. The highest detected compound was located at sample location WRF08B, which was collected along the drainage swale immediately downgradient from the former oil/water separator. The source of the contamination is most likely runoff from the former oil/water separator and the former washrack. PCB-1260 was also detected in one storm water sample (WRF08) at a concentration of 1.50 µg/L and was collected at the culvert outfall as shown on Figure 5-8.

### 5.4.2 USAEC Site Inspection, 1993 and Supplemental Site Inspection, 1994

Four sediment and three surface water samples (sample designations 22SE01, 22SE02/22SW02, 22SE03/22SW03, and 22SE04/22SW04) were collected during the 1993 SI. Samples associated with OU3 (22SE01, 22SW02/22SE02, 22SW041, and 22SE04) are presented on Figure 5-8. The samples were collected after a storm event to characterize the potential for contaminant migration from potential source areas to the Main Ditch. The samples were analyzed for TPH.

In addition, one sediment sample (11SE0101) and one surface water sample (11SW01) was collected from the outfall area associated with AREE 11 (Oil/Water Separator, north of Building 202). The sample was analyzed for VOCs, SVOCs, TPH, and pesticides/PCBs. The sample locations are presented on Figure 5-8.

#### 5.4.2.1 Summary of Results

TPH was detected in two of the four sediment samples (22SE01 and 22SE02) at levels of 18.0 and 14.0 µg/g, respectively. PCB-1260 was detected in the sediment sample collected from the outfall area at a concentration of 1,170 µg/g (USAEC, 1995b). Other compounds detected from this sample include: 1,4-dichlorobenzene (39.0 µg/g); 1,2-dichlorobenzene (8.60 µg/g); 1,2,4-trichlorobenzene (260 µg/g); and chlorobenzene (1.60 µg/g).

## 5.5 OU4 PREVIOUS INVESTIGATIONS

OU4 contains the remaining 17 AREEs, all of which are located throughout WRF. These AREEs are as follows: 9, 23a, 24e, 24f, 25, 26, 27, 29, 30, 33 through 39, and 41. Previous investigations have been performed to evaluate the nature and extent of contamination at AREEs within OU4. The results of the previous investigation for OU4 are presented below in numerical order for each of the AREEs.

### 5.5.1 AREE 9 - Salt Contamination at Test Areas

When WRF was an active research and testing facility, small amounts of calcium chloride were routinely mixed in the soil during field tests to improve the electrical grounding characteristics of the soil. Since calcium chloride is not a RCRA-listed hazardous material, the BCT decided to take no further action for this AREE. Therefore, no investigations were performed to evaluate this AREE.

### 5.5.2 AREE 23a - Former UST (Building 101)

AREE 23a is the site of a former 1,000-gallon steel UST used for No. 2 fuel oil storage located adjacent to Building 101 (Figure 5-8). The tank was installed in 1966, and was removed in 1991 when it failed a leak test. It was replaced with an above ground storage tank.

In November 1994, Dow Environmental performed a site characterization of AREE 23a. Four soil borings were drilled with direct push sampling technology to a depth of 9 feet bgs. A minimum of two samples were collected from each boring. A drill was also used to access the soil underneath Building 101 and a hand auger was used to collect a soil sample from 2 to 3 feet bgs within Building 101. Soil samples were analyzed for TPH. TPH was detected in subsurface soil samples collected from one of the borings at concentrations of 10,700 µg/g (WRF-T101-2-4-6) and 12,000 µg/g (WRF-T101-2-7-9), collected at depths of 5 and 8 feet bgs, respectively. These results are significantly above the VADEQ action level of 100 µg/g. A groundwater investigation was then performed which included the installation of three wells and the collection of subsurface soil samples at 5 to 7 feet bgs during well installation. TPH was detected in groundwater samples collected from newly-installed monitoring wells at concentrations of 0.2 mg/L and 0.15 mg/L. These concentrations are below the Commonwealth of Virginia guideline of 1 mg/L for TPH in groundwater. TPH was not detected in the soil samples collected from the well installation (USAEC, 1995c).

### 5.5.3 AREEs 24e and 24f - Former USTs

AREEs 24e (550-gallon) and 24f (280-gallon) are the sites of two former USTs located south of Building 306 which were used to store #2 fuel oil and diesel, respectively. Locations of AREEs 24e and 24f are presented on Figure 2-4. Although Weston (1992) identified these USTs as an AREE, they were not included in the SI or SSI for investigation. DOW Environmental investigated AREE 24f in November 1994, and TPH was detected in a subsurface soil sample at 39 µg/g, below the VADEQ action level of 100 µg/g (USAEC, 1995d). Both USTs were removed in November 1996. All excavated soils appeared to be clean and no evidence of tank failure was found. Soil samples were collected during removal and TPH was detected at a concentrations of 28.3 mg/kg from the excavation of 24e and at a concentration of 49.7 mg/kg from 24f. It was later determined that the soils were suitable for use as backfill material and, therefore, the excavated soils were placed back in their respective pits. No further action is recommended for these AREEs, and the VADEQ NRO has issued a letter of closure on these two sites.

### 5.5.4 AREEs 25, 26, 27, 35, 38, and 39

Investigations performed for the SI and the SSI were conducted to evaluate the nature and extent of contamination associated with AREEs 25, 26, 27, 35, 38, and 39 which are located within OU4. The location of these AREEs are presented on Figure 2-4.

AREE 25 (Sewage Injection Area) is comprised of three sewage injection areas located north of the Main Facility Compound, west of the main compound along the drainage ditch, and east of Lake Drive near the pond, as shown on Figure 2-4.

AREE 26 (Buried Antifreeze Pipes) is located south of Building 306 and consists of buried rubber hoses filled with antifreeze (Figure 2-4). These were used as test materials for the detection of personnel intrusion security monitoring. The antifreeze, which consisted mostly of ethylene glycol, was put in neoprene rubber hoses which were cut at various lengths and then sealed. The hoses were then buried in the ground at depths of 1 to 3 feet.

AREE 27 (Buried Wire in Test Areas) consists of electrical cable buried throughout the facility as part of an antenna system for a worldwide communication network (Figure 2-4). The antenna system was used until 1970. The buried cable typically consisted of a copper conductor surrounded by a metal

shield that was believed to contain copper, aluminum, or stainless steel, all encased in a plastic outer coating.

AREE 35 consists of antenna fields located throughout WRF, which contained PCB-contaminated transformers mounted to the antenna poles (Figure 2-4). These antenna fields were located adjacent to the western and southern fence line at the Main Facility Compound. It is possible that PCBs from these transformers may have contaminated the soil and groundwater.

AREE 38 is located on the southern boundary of the installation, along the fence line adjacent to Marumsco Creek National Wildlife Refuge (Figure 2-4). During July 1994, a class of students from Northern Virginia Community College (NVCC) and Garfield High School collected soil samples from the boundary of the wildlife refuge, including an area on WRF. The students of NVCC reportedly found mercury at a concentration of 350  $\mu\text{g/g}$ ; however, the analytical results have not yet been validated, and there are uncertainties associated with the accuracy of the mercury analytical data. The results of the Garfield High School soil samples were reported by a Garfield High School teacher as qualitative data.

#### **5.5.4.1 Results of Previous Investigation**

AREE 25, the sewage injection areas, were investigated during Phase I and II of the SI. Surface soil samples (25SS01 through 25SS18) were collected from 0 to 2 feet bgs and analyzed for metals and pesticides/PCBs. Arsenic, beryllium, iron, and manganese were detected at levels above RBCs (USAEC, 1995a and b). PCBs and pesticides were not detected. Sample locations are presented on Figure 5-9.

In AREE 26, buried hoses were located and found to be intact during excavation activities conducted for Phase II of the SI. Liquid samples of the contents of the hoses confirmed that the contents consisted of ethylene glycol (800,000 mg/L). Soil samples (26EX01 through 26EX06) were also collected from some of the excavations and analyzed for VOCs, SVOCs, TPH, pesticides/PCBs, and metals. Ethylene glycol, detected in two samples, was the only organic detected at concentrations of 690  $\mu\text{g/g}$  and 54.8  $\mu\text{g/g}$ , which are below the RBC of 160,000  $\mu\text{g/g}$ . Arsenic, beryllium, and manganese were detected above RBCs (USAEC, 1995a). The ethylene glycol hoses were removed during a removal action that was performed in the late fall/early winter 1996.

In AREE 27, the locations with buried cable were investigated during Phase I of the 1993 SI. Six surface soil samples (27SS01 through 27SS06) were collected and analyzed for metals and pesticides/PCBs. Neither PCBs nor pesticides were detected. Beryllium, iron, manganese, and potassium were detected above RBCs (USAEC, 1995a). Sample locations are shown on Figure 5-9.

In AREE 35, the antenna fields were investigated during Phase II of the SI. Approximately 100 PCB screening samples were collected from areas that may have been affected by the former antenna fields. Several of the screening samples contained detectable levels of PCBs. Twelve confirmatory surface soil samples (35SS01 through 35SS12) were then collected (seven from areas where PCB screening results were positive) and sent to the laboratory and analyzed for pesticides/PCBs, VOCs, BNAs, TPH, and metals. No PCBs were detected, but DDT (0.037  $\mu\text{g/g}$ ) was detected below the RBC (1.9  $\mu\text{g/g}$ ) in sample 35SS0801. No other organic compounds were detected in these samples. Aluminum, arsenic, beryllium, iron, manganese, and vanadium were detected above residential RBCs. Figure 5-9 shows the locations of the twelve surface soil samples.

AREE 38 was investigated during Phase II of the SI. Four soil samples were collected in the area where the NVCC samples were collected. The samples were analyzed for mercury and the highest level detected was 0.05  $\mu\text{g/g}$  (Waugh, 1996).

During the Phase II SI, five surface soil samples (38SS01 through 38SS05) were collected along the fence line adjacent to Marumsco Creek where the sample containing mercury was collected. The samples were analyzed for VOCs, BNAs, pesticides/PCBs, TPH, and metals. Acetone and methyl ethyl ketone were both detected in samples 38SS01 and 38SS03 with the highest concentrations detected in 38SS01 at 0.057  $\mu\text{g/g}$  and 0.011  $\mu\text{g/g}$ , respectively. Toluene (0.0044  $\mu\text{g/g}$ ) and TPH (80.7  $\mu\text{g/g}$ ) were detected in one sample each. None of these compounds were above RBCs and the TPH concentration was below the VADEQ action level of 100  $\mu\text{g/g}$ . Mercury was not detected, however, beryllium and arsenic were detected above residential RBCs (USAEC, 1996). Beryllium was detected above the RBC

(0.15 µg/g) in four of the samples with a maximum concentration detected of 0.826 µg/g. Arsenic was above the RBC (0.43 µg/g) in all five samples with a maximum detected concentration of 3.12 µg/g. Sample locations are shown on Figure 5-9.

#### **5.5.5 AREE 29 - Virginia Electric Power Company Transformer Spill**

AREE 29 is the location of an electrical substation which leaked PCB contaminated dielectric fluid in January 1984. The substation is located opposite of Building 101. Virginia Electric Power Company (VEPCO), the owner of the power substation, did attempt to cleanup the spill and collected soil samples which contained PCB concentrations of 0.01-0.02 µg/g (USAEC, 1996a). The location of AREE 29 is presented on Figure 2-4.

Four PCB surface soil screening samples collected within the spill area during Phase II of the SI contained PCB concentrations ranging from 0.5 to 1.0 µg/g. Three surface soil samples were then collected and sent to a laboratory for VOCs, BNAs, pesticides/PCBs, TPH, and metals analysis. No PCBs were detected; no inorganic compounds were detected above the RBC; and no significant organic compounds were detected.

#### **5.5.6 AREE 30 - Hydraulic Oil Spill**

AREE 30 is located on the north side of Dawson Beach Road near the intersection of Lake Drive (Figure 2-4). A hydraulic line on a mobile crane failed while the crane was in the process of loading excess equipment onto a trailer for off-site disposal. Approximately 50 gallons of hydraulic oil leaked from the crane. The installation's staff responded promptly with empty drums and absorbent pads and approximately 15 tons of contaminated soil were collected and disposed of off-site.

Four surface soil samples (30SS01 through 30SS04) were collected and analyzed for VOCs, BNAs, pesticides/PCBs, TPH, and metals. TPH was detected above the Virginia UST Action Level (100 µg/g) at a concentration of 1,160 µg/g. No other organic compounds were detected above residential RBCs. Arsenic was detected in all samples above the RBC (0.43 µg/g) at a maximum concentration of 3.69 µg/g. Sampling locations are presented in Figure 5-8. The hydraulic oil spill was treated promptly after release. The TPH detected is suspected to be limited to an isolated area and because the area is vegetated the migration of TPH is minimal.

#### **5.5.7 AREE 33 - Bulldozer Fuel Spills**

In January 1990, approximately 100 gallons of water contaminated with diesel fuel was drained in an area west of the Main Facility Compound (refer to Figure 2-4). Approximately 100 tons of contaminated soil were excavated and sent off-site for incineration.

Four surface soil samples were collected during the Phase II SSI and analyzed for VOCs, BNAs, pesticides/PCBs, TPH, and metals. No organic compounds were detected above the RBCs (USAEC, 1996a).

#### **5.5.8 AREE 34 - Hunter Qualification Target Range**

AREE 34 is located in a 100 foot wide by 600 foot long area east of the Main Facility Compound and south of Charlie Road as shown on Figure 2-4. The area was used once a year to qualify approximately 100 hunters to deer hunt at WRF. Each hunter was allowed to shoot 5 bullets into targets. The policy has been in effect since 1994 (USAEC, 1996a).

Four surface soil samples were collected during the Phase II SSI and analyzed for VOCs, BNAs, pesticides/PCBs, TPH, and metals. Two pesticides, DDE and DDT, were detected in one sample at concentrations below the RBC. Significant levels of inorganic compounds were not detected (USAEC, 1996a).

#### **5.5.9 AREE 36 - GVF Test Structure**

AREE 36 is the GVF Test Structure, located to the southwest of the Main Facility Compound as shown in Figure 2-4. The building is windowless and is constructed of masonry walls with a gypsum wallboard interior. The walls are spray-coated with copper and zinc for the purpose of providing a radio-frequency shielded room. The building has only one entrance, accessed by a heavy duty metal door

designed as a component of the radio-frequency shielding. The hazardous waste experts at the ARL have concluded that the metal clad gypsum wallboard is not hazardous and is therefore not a hazardous waste requiring disposal considerations. AREE 36 was not investigated during the RI.

#### **5.5.10 AREE 37 - Creosote Poles**

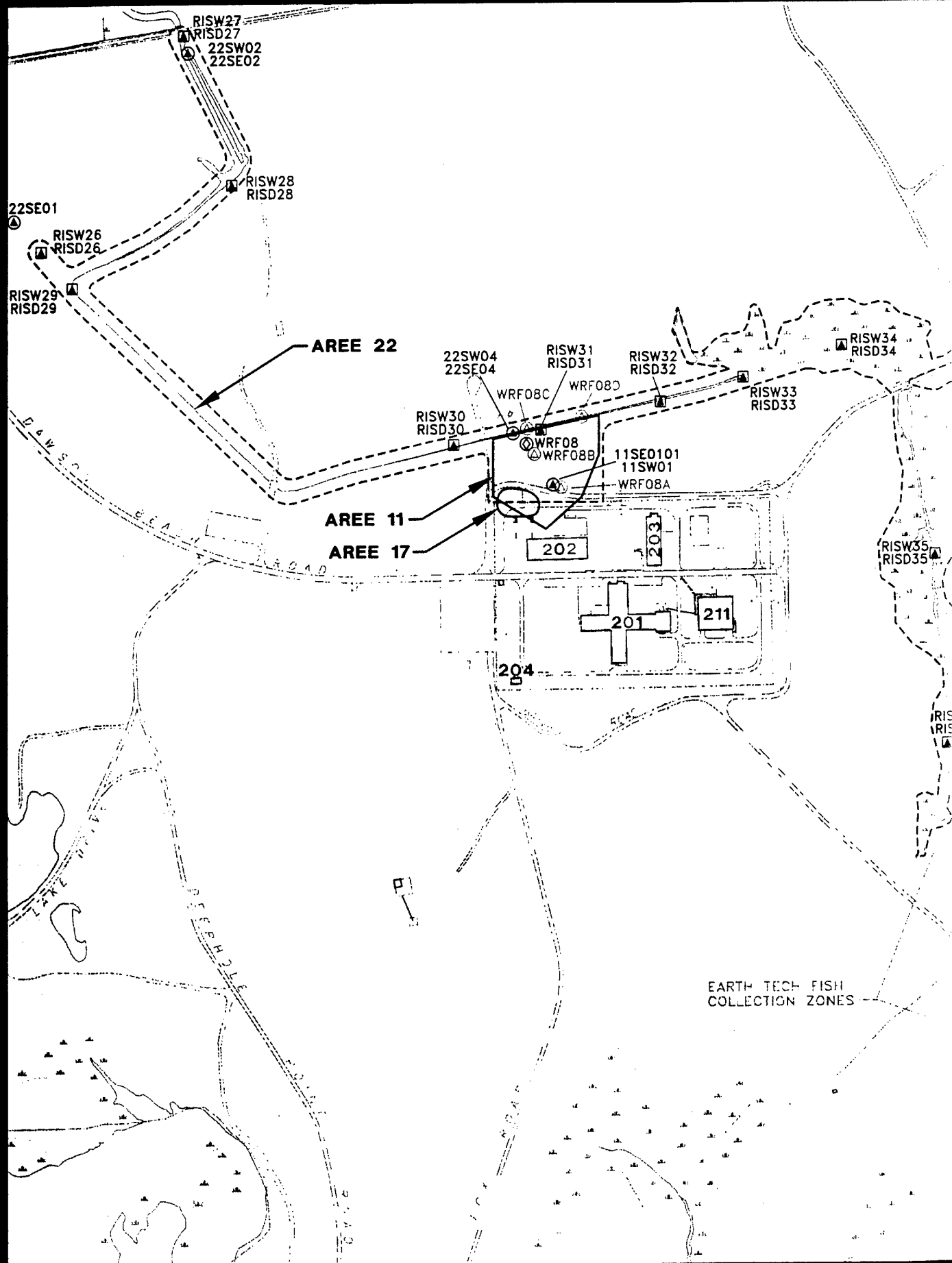
AREE 37 consists of suspected former disposal areas for creosote-treated poles located in the wetlands habitats throughout much of WRF. The poles were used to support antenna arrays at the installation when it operated as a radio transmitting facility until the late 1960s. In 1994, the Baltimore District, U.S. Army Corps of Engineers was tasked to remove the creosote-treated poles from the facility. Because the exact number, location, and condition of the poles was unknown, an investigation site walk was performed. No discrete disposal areas were identified during the site walk and the BCT recommended that no further action be considered for this AREE.

#### **5.5.11 AREE 39 - Debris Piles**

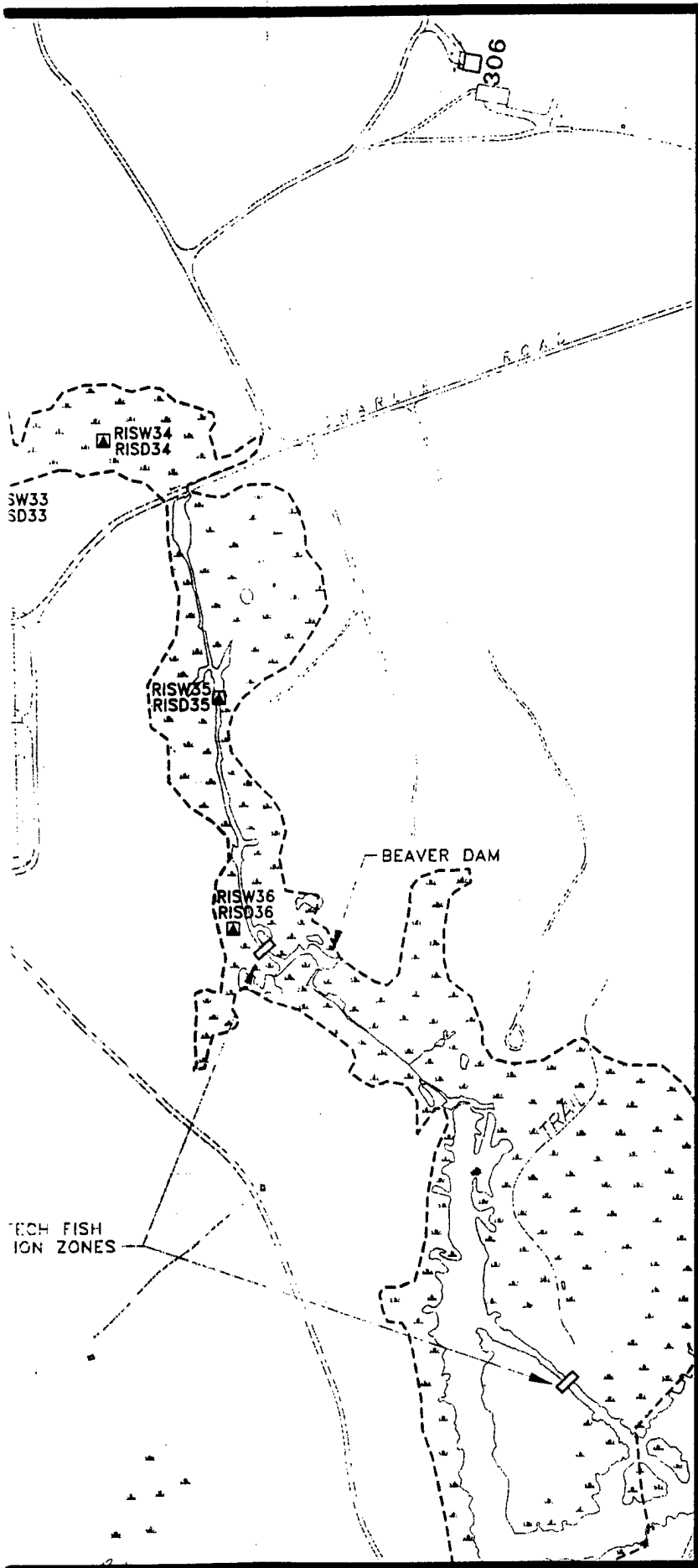
During a facility site walk conducted by the BCT in January 1995, debris piles consisting of metallic debris, construction material, and unidentified piles of soil were identified south of the Hunter Qualification Range. This area was designated as AREE 39 by the BCT in February 1995, as presented in Figure 2-4.

Three surface soil samples were collected and screened for PCBs using PCBs screening kits during the Phase II SI. PCBs were not detected from the screening tests. Three surface soil samples (locations 39BH01 through 39BH03) and two subsurface soil samples (locations 39BH02 and 39BH03) from 3 feet bgs were collected and analyzed for VOCs, BNAs, pesticides/PCBs, TPH, and metals. DDT and DDE were detected in four samples. DDT concentrations ranged from 0.0184  $\mu\text{g/g}$  in sample 39BH0201 to 0.15  $\mu\text{g/g}$  in sample 39BH0202. DDE concentrations ranged from 0.0472  $\mu\text{g/g}$  in sample 39BH0201 to 0.46  $\mu\text{g/g}$  in sample 39BH0301. Styrene and acetone were detected in sample 39BH0101 at concentrations of 0.011  $\mu\text{g/g}$  and 0.026  $\mu\text{g/g}$ , respectively. Benzoic acid was detected in sample 39BH0201 at a concentration of 4  $\mu\text{g/g}$ . Benzoic acid was not detected in the sample collected at 3 feet bgs at the same sample location. All organic concentrations were below residential RBCs. Arsenic, iron, and manganese were detected above their respective residential RBCs (USAEC, 1996a). Sample locations are presented in Figure 5-9.

**Figure 5-8**  
**Sample Locations Associated with the**  
**Upper Reaches of the Main Ditch and Main Compound Area**

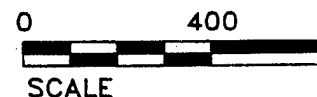


EARTH TECH FISH  
COLLECTION ZONES



# LEGEND:

- ▲ 1995 RI SURFACE WATER/SEDIMENT SAMPLE LOCATION
- Ⓐ SI SURFACE WATER/SEDIMENT SAMPLE LOCATION
- Ⓑ VADEQ SURFACE WATER/SEDIMENT SAMPLE LOCATION
- Ⓒ VADEQ STORM WATER SAMPLE LOCATION
- LOCATION OF OU3
- == ROAD
- FENCE
- ~ WATER
- ... SWAMP



<b>US ARMY ENVIRONMENTAL C</b>	
CONTRACT NO. DACA31-94-D-0064	
<b>◆ ICF KAISER</b> 2113 Emmorton Park Drive Suite 100 Edgewood, Maryland 21040 (410) 612-6350	WOOD <b>SAM ASSC UPP THE MAIN</b>
PREPARED CST	TASK NO: 68220
CHECKED PT	ICF DWG NO:
DATE 10-27-97	OU3-SMP



**LEGEND:**

1995 RI SURFACE WATER/SEDIMENT  
SAMPLE LOCATION

SI SURFACE WATER/SEDIMENT  
SAMPLE LOCATION

VADEQ SURFACE WATER/SEDIMENT  
SAMPLE LOCATION

VADEQ STORM WATER SAMPLE  
LOCATION

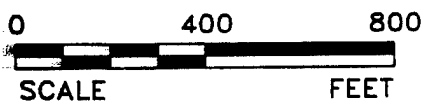
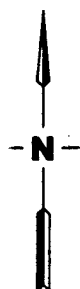
LOCATION OF OU3

ROAD

FENCE

WATER

SWAMP



**US ARMY  
ENVIRONMENTAL CENTER**

CONTRACT NO. DACA31-94-D-0064

FIGURE 5-8

ICF KAISER

2113 Emmorton Park Drive  
Suite 100  
Edgewood, Maryland 21040  
(410) 612-6350

WOODBRIE RESEARCH FACILITY

REPAIRED CST

TASK NO: 68220

CHECKED PT

ICF DWG NO:

DATE 10-27-97

OU3-SMP

**SAMPLE LOCATIONS  
ASSOCIATED WITH THE  
UPPER REACHES OF  
THE MAIN DITCH AND  
MAIN COMPOUND AREA**

3

**Section 7.0**  
**Summary of Investigations**

## 7.0 SUMMARY OF INVESTIGATIONS

This section presents sample results of the fieldwork portion of the RI, which was initiated in the late fall of 1995 and early winter of 1996 (USAEC, 1995b). The RI field effort consisted of two phases that ended in the late summer of 1996. The first section describes the samples collected from background locations. Remaining sections present sampling rationale, sampling locations, and analytical results for AREEs within OU1, OU2, OU3, OU4, and the site-wide investigation. An electronic version of the data entered into IRDMIS for this project is included with this report as Appendix D (hard copies of the IRDMIS data base is provided in the RI reports that have been distributed to the regulatory agencies, USAEC, the Army Research Laboratory, and the WRF information repository located at the WRF).

### 7.1 USAEC REMEDIAL INVESTIGATION BACKGROUND SAMPLING, 1996

The following samples were collected from background locations near and within WRF: five surface soil samples (0-6 inches bgs); three surface soil samples (0 to 2 feet bgs) and six subsurface soil samples (varying depths) collected from borings which were later converted to monitoring wells; two rounds of groundwater samples from four background monitoring wells; and five surface water and sediment samples. This section presents the results of the background analyses. The locations for on-site background samples are presented on Figure 6-1 and the locations for the surface water/sediment samples are presented in Figure 6-2. Table 6-1 presents background sample identifications, sample depths (where applicable), and the types of analyses performed for each sample.

#### 7.1.1 Determination of Background Concentrations

A statistical analysis was performed for all sampled media to determine which inorganic chemicals detected on-site were within background concentrations. In order to determine if detected levels of inorganic compounds present at the site were representative of naturally occurring background levels, on-site data for each medium were statistically compared to site-specific background data.

##### 7.1.1.1 Surface Soil

Five surface soil samples (RIBKSS1 through RIBKSS5) were collected from on-site locations that were upgradient and/or unaffected by past site activities. The locations of the surface soil samples are presented on Figure 6-1. These five background surface soil samples were analyzed for TCL, VOCs, TCL SVOCs, pesticides/PCBs, PAHs, PCTs, TPH, and TAL metals. Inorganics detected in background surface soil samples are presented in Table 7-1. Organics detected in background surface soil samples are presented in Table 7-2.

Summary of Results. The following is a summary of the inorganics detected in the background surface soil samples. Aluminum was detected in all samples in a range of concentrations from 6,550 µg/g to 14,600 µg/g. Arsenic was detected once at 3.85 µg/g in RIBKSS1, but was not detected in the duplicate. Barium was detected in RIBKSS3 and RIBKSS5 at 67 µg/g, and 73.4 µg/g, respectively. Beryllium was detected in all samples except RIBKSS4, with a maximum detected concentration of 0.785 µg/g. Calcium was detected in all samples except RIBKSS1 with a maximum concentration of 1,020 µg/g. Chromium, cobalt, copper, and iron were detected in all samples with maximum detected concentrations of 26.7 µg/g, 12.7 µg/g, 12.6 µg/g, and 23,900 µg/g, respectively. Lead was detected in all samples except RIBKSS2 with a maximum detected concentration of 22.4 µg/g. Magnesium, manganese, nickel, potassium, sodium, vanadium, and zinc were also detected in all samples with maximum detected concentrations of 1,700 µg/g, 677 µg/g, 8.98 µg/g, 597 µg/g, 487 µg/g, 47.1 µg/g, and 40.4 µg/g, respectively. Selenium was detected in one sample (RIBKSS3) at 14.2 µg/g.

Four organic compounds, benzo(b)fluoranthene, benzo(k)fluoranthene, fluoranthene, and indeno(1,2,3-cd)pyrene, were detected in all background surface soil samples at maximum concentrations of 0.01 µg/g (RIBKSS3), 0.005 µg/g (RIBKSS3 and RIBKSS5), 0.018 µg/g (RIBKSS3), and 0.01 µg/g (RIBKSS4), respectively. Aldrin and methylene chloride were detected at one location at concentrations of 0.003 µg/g (RIBKSS2), and 0.02 µg/g (RIBKSS5), respectively. Anthracene and benzo(g,h,i) perylene were detected at maximum concentrations of 0.028 µg/g and 0.011 µg/g, respectively in samples collected from RIBKSS3, RIBKSS4, and

RIBKSS5. Benzo(a)anthracene, benz(a)pyrene, and pyrene were detected in all samples except RIBKSS1, with maximum concentrations of 0.005 µg/g, 0.008 µg/g, and 0.023 µg/g, respectively. Phenanthrene was detected in RIBKSS1 and RIBKSS2 with a maximum concentration of 0.347 µg/g in RIBKSS1.

#### 7.1.1.2 Subsurface Soil

Subsurface soil samples were collected from borings in which background monitoring wells MW-52, MW-53, and MW-54 were installed for the RI. The locations for these samples are shown on Figure 6-1. The samples were collected from 0 to 2 feet bgs and every 5 feet thereafter to the water table. All subsurface soil samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, and PCTs. The soil samples collected from these background locations were grouped into two categories for risk assessment purposes.

The first grouping (which consists of three samples) were samples collected from 0 to 2 feet bgs. These data were combined with the five background surface soil samples discussed in Section 7.1.1.1 to bolster the data set for background surface soil. Therefore, a total of eight surface soil samples were used to statistically determine which site surface soil concentrations were within background levels. Detections reported for this set of subsurface soil samples is given in Table 7-3.

The second grouping from the subsurface soil samples consisted of samples collected at depths below 2 feet bgs. The six samples collected from 2 feet bgs to the water table were grouped for the purposes of determining which compounds detected in on-site samples were within background levels. Detections reported for this set of subsurface soil samples is presented in Table 7-4.

**Summary of Results.** The following inorganics were detected in all subsurface soil samples from 0 to 2 feet bgs (the maximum concentration detected is also listed): aluminum, 22,000 µg/g; beryllium, 0.814 µg/g; calcium, 1,150 µg/g; chromium, 31.3 µg/g; cobalt, 16.6 µg/g; copper, 11.5 µg/g; iron, 28,100 µg/g; magnesium, 2,610 µg/g; manganese, 875 µg/g; nickel, 11.9 µg/g; potassium, 936 µg/g; sodium, 453 µg/g; vanadium, 58.9 µg/g; and zinc, 43.9 µg/g. Barium and lead were detected in MW-53 and MW-54 soils from 0 to 2 feet bgs with maximum concentrations of 92.4 µg/g and 17.7 µg/g, respectively. Arsenic was detected in MW-53 from 0 to 2 feet bgs at 3.24 µg/g. Selenium was detected in the MW-54 subsurface 0 to 2 feet bgs soil sample at 13 µg/g. Bis(2-ethylhexyl)phthalate was the only organic to be detected in subsurface soil samples from 0 to 2 feet bgs. It was detected in MW-53 and MW-54 at 0.18 µg/g and 0.50 µg/g, respectively.

The following inorganics were also detected in most subsurface soil samples collected from 2 feet bgs to the water table (maximum detected concentration is also listed): aluminum, 18,200 µg/g; barium, 93 µg/g; beryllium, 1.02 µg/g; calcium, 911 µg/g; chromium, 25 µg/g; cobalt, 13.9 µg/g; copper, 19.1 µg/g; iron, 27,800 µg/g; magnesium, 3,700 µg/g; manganese, 617 µg/g; nickel, 20.9 µg/g; potassium, 624 µg/g; sodium, 939 µg/g; vanadium, 60.3 µg/g; and zinc, 55.6 µg/g. No organic compounds were detected in subsurface soil samples from 2 feet bgs to the water table.

#### 7.1.1.3 Sediment

Five sediment samples (RISDBK1 through RISDBK5) were collected from Mason Neck Wildlife Refuge, which is located east of WRF and the Potomac River. Since Mason Neck is located across the Potomac River from WRF, it has not been impacted from past activities related to WRF. The samples were collected from 0 to 6 inches and were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PAHs, TAL metals, PCTs, TPH, grain size distribution, and Total Organic Carbon (TOC). Background sediment sample locations are presented in Figure 6-2. Tables 7-5 and 7-6 present the inorganic and organic compounds detected in the background sediment samples, respectively.

**Summary of Results.** The following inorganics were detected in all sediment background samples (maximum detected concentration is also listed): aluminum, 16,900 µg/g; beryllium, 1.38 µg/g; calcium, 6,000 µg/g; chromium, 33.7 µg/g; cobalt, 21.4 µg/g; copper, 44.4 µg/g; iron, 36,500 µg/g; magnesium, 3,740 µg/g; manganese, 1,690 µg/g; nickel, 30.3 µg/g; potassium,

2,120 µg/g; sodium, 1,710 µg/g; vanadium, 54.1 µg/g; and zinc, 168 µg/g. In addition, barium was detected in RISDBK1 at 175 µg/g and lead was detected in four of the background sediment samples with a maximum detected concentration of 42.2 µg/g.

Several PAHs, including anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, and pyrene were detected in most if not all background sediment samples at low levels (<1 µg/g). In addition, 1-methylnaphthalene, benzo(b)fluoranthene, and fluorene were detected in three background sediment samples with maximum detected concentrations of 1.14 µg/g, 0.083 µg/g, and 0.355 µg/g, respectively. Acenaphthene and methylene chloride were detected in two background samples with a maximum detected concentrations of 1.27 µg/g and 0.061 µg/g, respectively. Naphthalene was detected in RISDBK3 at 0.636 µg/g.

#### 7.1.1.4 Surface Water

At each sediment sample location, a surface water sample was also collected. Surface water samples were collected from 0-6 inches below the water surface and were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PAHs, TAL metals, PCTs, TPH, total suspended solids, alkalinity, and hardness. Background surface water sample locations are presented in Figure 6-2. Detected inorganic compounds detected in the surface water samples are given in Table 7-7.

Summary of Results. The following inorganics were detected in all surface water background samples (maximum detected concentration is also listed) aluminum 1,930 µg/L; barium 41.8 µg/L; calcium 22,200 µg/L; iron 2,510 µg/L; lead 1.9 µg/L; magnesium 7,500 µg/L; manganese 303 µg/L; potassium 3,670 µg/L; and sodium 16,500 µg/L. The concentrations detected in the surface water samples did not vary much from sample to sample. Arsenic was detected in RISWBK1 at 1.4 µg/L and chromium was detected in RISWBK2 at 10.8 µg/L. No organic compounds were detected in background surface water samples.

#### 7.1.1.5 Groundwater

Two rounds of groundwater samples were collected from shallow monitoring wells MW-52, MW-53, MW-54, and deep monitoring well MW-63 for a total of eight samples. All groundwater samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PCTs (first round only), TAL metals, PAHs, and TPH. These samples were used to characterize background concentrations for groundwater. Refer to Figure 6-1 for the location of the background monitoring wells. Table 7-8 is a summary of the inorganic compounds detected in the background groundwater samples. Table 7-9 is a summary of the organic detections reported by the laboratory for the background groundwater samples.

Summary of Results. The following inorganics (maximum concentration detected is also listed) were detected in most if not all background groundwater samples: aluminum, 12,500 µg/L; barium, 107 µg/L; calcium, 42,800 µg/L; iron, 9,620 µg/L; magnesium, 7,720 µg/L; manganese, 354 µg/L; potassium, 20,900 µg/L; and sodium, 44,300 µg/L. Arsenic was detected in wells MW-53 and MW-63 with a maximum detected concentration of 6.9 µg/L. Cadmium was detected in wells MW-53, MW-54 and MW-63 with a maximum detected concentration of 0.8 µg/L. Chromium and copper were detected at 22.3 µg/L and 8.9 µg/L, respectively in MW-53. Lead was detected in MW-53 with a maximum detected concentration of 6.3 µg/L. Nickel was detected at 18.4 µg/L in MW-52. Selenium was detected in all wells except MW-54 (maximum concentration of 4.2 µg/L) during the first round of sampling but was not detected in samples collected during the Round 2 sampling. Thallium was detected in MW-53 at 0.1 µg/L in the Round 1 sample but was not detected in the Round 2 sample. Vanadium was detected in MW-63 for samples collected from both sampling rounds and in well MW-53 in the sample collected during Round 1. The maximum detected concentration of vanadium in the background samples was 31.4 µg/L (MW-63). Zinc was detected in samples from wells MW-52 and MW-53 during the Round 1 sampling and in the MW-52 sample during Round 2 with a maximum detected concentration of 46.0 µg/L.

The following organic compounds were detected in groundwater samples collected from MW-63 during Round 1: 1-methylnaphthalene (119 µg/L); 2-methylnaphthalene (80.5 µg/L); acenaphthene (11.0 µg/L); acenaphthylene (6.34 µg/L); endosulfan B (0.021 µg/L); endosulfan sulfate (0.027 µg/L); endrin (0.022 µg/L); ethylbenzene (13 µg/L); fluoranthene (0.063 µg/L); fluorene (3.2 µg/L); naphthalene (30 µg/L); phenanthrene (8.69 µg/L); pyrene (0.158 µg/L); toluene (5.2 µg/L); TPH, as diesel (900 µg/L); TPH, as gas (740 µg/L); and xylenes (54 µg/L). An additional AREE (AREE 41, Old Homestead) was created to further evaluate an old homestead area that may be the source for the contamination detected in this well. Inorganic results from MW-63 were used to develop site specific background concentrations in groundwater. It should be noted that organic compounds that were detected in groundwater were not used to establish an background organic data base.

Organic compounds (and their respective maximum concentrations) detected during Round 2 sampling are as follows: 1-methylnaphthalene (101 µg/L); 2-methylnaphthalene (79.3 µg/L and 78.8 µg/L in MW-63 duplicate); acenaphthene (4.17 µg/L and 8.27 µg/L in MW-63 duplicate); acenaphthylene (3.01 µg/L); anthracene (2.00 µg/L); BHC, B (0.017 µg/L); BHC, G (0.098 µg/L); dieldrin (0.026 µg/L) and 0.018 µg/L in MW-63 duplicate; dimethyl phthalate (3.90 µg/L in MW-63 duplicate); endosulfan sulfate (0.019 µg/L); ethylbenzene (5.30 µg/L) and 5.20 in MW-63 duplicate; fluoranthene (0.069 µg/L) and 2.01 in MW-63 duplicate; heptachlor (0.011 µg/L in MW-63 duplicate); naphthalene (18.0 µg/L) and 15.2 µg/L in MW-63 duplicate; phenanthrene (6.43 µg/L) and 6.35 µg/L in MW-63 duplicate; pyrene (0.0162 µg/L) and 0.137 µg/L in MW-63 duplicate; toluene (2.30 µg/L) and 2.10 µg/L in MW-63 duplicate; TPH, as diesel (1,140 µg/L) and 1,130 µg/L in MW-63 duplicate; TPH, as gas (558 µg/L) and 538 µg/L in MW-63 duplicate; and xylenes (32.0 µg/L) and 31.0 µg/L in MW-63 duplicate.

Inorganic compounds detected in Round 1 from MW-63 are as follows: aluminum (635 µg/L); arsenic (1.6 µg/L); barium (30.8 µg/L); calcium (24,300 µg/L); iron (433 µg/L); magnesium (3,580 µg/L); manganese (12 µg/L); potassium (14,000 µg/L); selenium 2.7 µg/L; sodium (41,300 µg/L); and vanadium (12.3 µg/L).

The following inorganics were detected in the groundwater sample and duplicate collected from MW-63: aluminum (780 µg/L) and 514 µg/L in the MW-63 duplicate; arsenic (6.9 µg/L) and 6.5 µg/L in the sample collected from the MW-63 duplicate; barium (30.3 µg/L) and 27.2 µg/L in the MW-63 duplicate; cadmium (0.2 µg/L in the MW-63 duplicate); calcium (42,800 µg/L) and 41,600 µg/L in the MW-63 duplicate; iron (532 µg/L) and 209 µg/L in the MW-63 duplicate; lead (1.2 µg/L) in the MW-63 duplicate; magnesium (225 µg/L) and 157 µg/L in the MW-63 duplicate; manganese (10.8 µg/L); potassium (20,900 µg/L) and 20,300 µg/L in the MW-63 duplicate; sodium (44,300 µg/L) and 42,700 µg/L in the MW-63 duplicate; and vanadium (31.4 µg/L) and 28.2 µg/L in the MW-63 duplicate.

Two organic compounds were detected in background monitoring well MW-52. Anthracene was detected at 0.113 µg/L in the MW-52 Round 1 sample but was not detected in the Round 2 sample. Endosulfan sulfate was detected in MW-52 Round 1 and 2 samples at concentrations of 0.146 µg/L and 0.138 µg/L, respectively. No organic compounds were detected in MW-53 and MW-54 groundwater samples.

## 7.2 OPERABLE UNIT ONE REMEDIAL INVESTIGATION RESULTS

OU1 is bounded by Deephole Point Road to the east, Lake Drive to the west, and Marumsc Creek and Occoquan Bay to the south. OU1 is comprised of eight AREEs: AREE 1 through AREE 6B (former dumps) and AREE 7 (former pistol range). The location of these AREEs within OU1 are presented in Figure 2-4. Tables 6-2 through 6-7 present a summary of the samples collected from the AREEs within OU1 for the RI.

## 7.2.1 AREE 1 Investigation Results

Since 1984 several investigations have focused on AREE 1, a 0.4-acre former dump site on the southwest portion of WRF, bordered by Occoquan Bay to the south and Marumsco Creek to the west. Results of previous investigations for AREE 1 are summarized in the FFS for OU1 (USAEC, 1997a).

The following sections describe the sampling rationale for the RI investigation, the location and the number of samples collected for each media, the analyses performed on each sample, and a summary of the results of these analyses. Figure 3-1 presents the locations of the monitoring wells installed for the RI and Figures 6-3 through 6-6 present the sample locations of all other media sampled for the RI. Table 7-10 includes a summary of the detection samples collected in AREE one and presents the detected compounds for all medial sampled.

### 7.2.1.1 Surface Soil

Seven surface soil samples (RISS1 through RISS4 and RISS54 through RISS56) were collected and analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PAHs, and PCTs to characterize the extent of surface soil contamination. The samples were collected from areas where stressed vegetation was observed, or in runoff areas. An exception to this was RISS1, which was collected from an area where a drum protrudes from the side of a hill. Figure 6-3 presents surface soil sample locations for AREE 1.

**Summary of Results.** The following inorganic compounds were detected at concentrations greater than the WRF site background maximum concentrations: aluminum, beryllium, calcium, chromium, cobalt, copper, iron, lead, mercury, potassium, sodium, and zinc. Figure 7-1 presents inorganic compounds detected above site background concentrations in surface soil samples collected in OU1.

PCB-1260 was detected in five surface soil samples collected in AREE 1: RISS1 at a concentration of 0.149 µg/g; RISS1DUP at a concentration of 0.037 µg/g; RISS4 at a concentration of 0.713 µg/g; RISS55 at a concentration of 0.279 µg/g; and RISS56 at a concentration of 0.054 µg/g. PCB-1260 is considered a carcinogenic mixture of PCB congeners and USEPA Region III recommends that the RBC for carcinogenic PCBs (0.083 µg/g) be used as a screening value. The detected concentrations in RISS1, RISS4, and RISS55 exceeded the carcinogenic RBC. PCB concentrations detected in surface soil, subsurface soil, test pit samples, and sediment samples are presented in Figure 7-2. Total pesticides and PAHs detected in surface soils are presented in Figure 7-3.

### 7.2.1.2 Subsurface Soil

Four downgradient soil borings (MW-77 through MW-80) were drilled in AREE 1 and subsurface soil samples were collected. The subsurface soil samples were collected from depths of 0 to 2 feet bgs and from 2 feet bgs to the water table. Groundwater monitoring wells were installed at each soil boring location. Boring logs and monitoring well completion diagrams are presented in Appendix C. These soil boring/monitoring well locations are closer to the known area of PCB contamination than the existing monitoring wells. Samples collected from these soil borings were used to further characterize and evaluate subsurface contamination in AREE 1. The subsurface soil samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, and PCTs. Inorganics and organics detections reported by the laboratory are presented in Table 7-10.

**Summary of Results.** The following inorganic compounds were detected at concentrations greater than their WRF site background maximum concentrations in the subsurface soil samples collected from 0 to 2 feet bgs: barium, beryllium, calcium, chromium, cobalt, lead, magnesium, mercury, nickel, potassium, selenium, sodium, vanadium, and zinc. Figure 7-1 presents inorganic compounds detected in subsurface soils (0-2 feet bgs) above background in OU1.

Several organic compounds (PAHs, pesticides, and PCBs) were detected in the subsurface soil samples collected from 0 to 2 feet bgs in AREE 1. Figure 7-3 presents total pesticides and PAHs detected in surface soil samples in OU1. PAHs and pesticides were detected in concentrations less than their respective RBCs. Endosulfan sulfate, which was detected in MW-77DUP, does

not have an RBC. However, for risk assessment purposes USEPA Region III recommends that the RBC for endosulfan (47  $\mu\text{g/g}$ ) be used as a screening value. The detected concentration of endosulfan sulfate (0.03  $\mu\text{g/g}$ ) is significantly less than the RBC. PCB-1260 was detected in two subsurface soil samples collected 0 to 2 feet bgs in AREE 1: MW-78 at a concentration of 0.11  $\mu\text{g/g}$ , and MW-80 at a concentration of 10.8  $\mu\text{g/g}$ . Although no RBC exists, PCB-1260 is considered a carcinogenic mixture of PCB congeners and USEPA Region III recommends the RBC for carcinogenic PCBs (0.083  $\mu\text{g/g}$ ) be used as a screening value. The detected concentrations in both MW-78 and MW-80 exceed the carcinogenic RBC. PCBs detected in surface and subsurface soil samples are shown on Figure 7-2.

For subsurface soil samples collected from two feet bgs to the water table, the inorganic compounds beryllium, calcium, cobalt, and vanadium were detected at concentrations greater than their respective site background concentrations. Beryllium (site background of non-detect) was detected in MW-76 in the sample collected from 5-7 feet bgs (0.390  $\mu\text{g/g}$ ) and in the 7-9 feet bgs sample (0.499  $\mu\text{g/g}$ ). Beryllium was also detected in MW-77 at 7-9 feet bgs at a concentration of 0.27  $\mu\text{g/g}$  and in MW-78 in the 7-9 feet bgs sample at a concentration of 0.34  $\mu\text{g/g}$ ; in MW-79 at 0.39  $\mu\text{g/g}$  (5-7 feet bgs) and MW-80 at a concentration of 0.47  $\mu\text{g/g}$  (5 feet bgs). Calcium was detected at a concentration of 702  $\mu\text{g/g}$  (site background concentration of 454  $\mu\text{g/g}$ ) in the 5-7 foot sample collected in MW-80. Calcium was also detected at concentrations of 726  $\mu\text{g/g}$  and 653  $\mu\text{g/g}$  in the MW-76 boring at depths of 5-7 feet and 7-9 feet bgs. Cobalt (site background of 13.9  $\mu\text{g/g}$ ) was detected at a concentration of 14.4  $\mu\text{g/g}$  in the 5-7 foot sample collected from the MW-80 soil boring. Vanadium (site background concentration of 25.8  $\mu\text{g/g}$ ) was detected in the 5-7 feet bgs sample at a concentration of 37.2  $\mu\text{g/g}$  and 27.7  $\mu\text{g/g}$  in the 7-9 feet bgs sample from MW-76 at a concentration of 27.7  $\mu\text{g/g}$ . No other inorganic compounds were detected above their respective RBCs. Inorganic compounds detected above background for subsurface soil samples are presented on Figure 7-4.

Several organic compounds including endosulfan sulfate, methoxychlor, and PCB-1260, were detected in soil samples collected 2 feet bgs to the water table. With the exception of PCB-1260, all organic compounds were detected at concentrations less than their respective RBCs. PCB-1260 was detected in soil boring MW-80, collected 5 feet bgs, at a concentration of 1.62  $\mu\text{g/g}$ , which exceeds the RBC for carcinogenic PCB congeners (0.083  $\mu\text{g/g}$ ). The sample locations with reported PCB detections in subsurface soil samples are presented on Figure 7-2. Total pesticides and PAHs detected in subsurface soil samples are presented in Figure 7-5.

### 7.2.1.3 Test Pits

Two test pits, TP1 and TP2, were excavated upgradient and downgradient, respectively, of the two trenches 20 and 21, previously excavated and sampled during the 1993 USAEC SI to determine the extent of PCB contamination identified during the SI. The Test Pit locations are given on Figure 7-2. Two additional test pits (TP24 and TP25) were excavated to investigate the extent of additional debris that was protruding from the side of a hill on the southern portion of OU1.

TP1, upgradient of previously excavated area 01EX02, was excavated in two segments. Segment 1 was 24 feet long and excavated to a depth of 6.25 feet bgs. Debris was encountered at the ground surface. No debris was encountered during the excavation. One sample, TP1A, and one duplicate, TP1A DUP, were collected at the surface where debris was located. Segment 2 was trenched perpendicular to the road where surface debris was visible. TP1, segment 2 was 25 feet long and excavated to a depth of 6.3 feet bgs. One sample, TP1B, was collected beneath the surface debris. No debris was encountered during the excavation. Soil samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, and PCTs.

TP2 was trenched downgradient of previously excavated area 01EX02 in two segments that cut perpendicular to each other. Segment 1 was 25 feet long and excavated to a depth of 7 feet bgs. One sample, TP2A, was collected where debris was located at 2 feet bgs. Segment 2 was 18 feet long and excavated to a depth of 7 feet bgs. One sample, TP2B, was collected where debris was located at 2 feet bgs. The debris unearthed consisted of sheet metal, plastic, cable, and pipe. Samples TP2A and TP2B were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, and PCTs.



TP24 was trenched in one segment perpendicular to TP1 and in two segments approximately 80 feet north of TP1. Visible debris on the surface was removed to allow continued excavation of soils beneath it. TP24 was 25 feet long and excavated to a depth of 5 feet bgs. No additional debris was recovered and no sample was collected.

TP25 was trenched in three segments approximately 90 feet south of TP2 in order to determine the lateral extent of debris. All segments were 15 feet long and excavated to a depth of 6 feet bgs. A metal pipe and piece of metal cable were unearthed during the excavation. No samples were collected from the excavations.

**Summary of Results.** The following inorganic compounds were detected at concentrations greater than each of the WRF site background maximum concentrations: calcium, barium, and iron (0 to 2 feet bgs), and lead, potassium, and vanadium (below 2 feet bgs). Inorganics detected in test pit samples collected from 0 to 2 feet bgs in OU1 are presented in Figure 7-1 and inorganics detected in test pit samples collected below 2 feet bgs are presented in Figure 7-4. Although several organic compounds were detected in test pit samples, none exceeded their respective RBCs.

Total pesticides and total PAHs detected in test pit samples collected from 0 to 2 feet bgs are presented in Figure 7-3 and total pesticides and PAHs detected in subsurface soil samples in OU1 is presented in Figure 7-5.

#### 7.2.1.4 Groundwater

Five downgradient monitoring wells (MW-76 through MW-80) were installed in areas nearer to the known area of PCB contamination than the existing wells (MW-7 through MW-12) to further characterize and evaluate groundwater contamination in AREE 1. Groundwater samples collected from these wells were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PAHs, TAL metals, and PCTs. A summary of the inorganic and organic compounds detected in the groundwater samples collected in AREE 1 is given in Table 7-10. Monitoring well locations are presented in Figure 3-1.

In addition to the newly installed wells, the existing wells (one upgradient well, MW-7, and five downgradient wells, MW-8 through MW-12) were also sampled. Monitoring well construction data for existing and new AREE 1 monitoring wells is presented as Table C-1 in Appendix C. As discussed earlier, PCBs were detected periodically during sampling activities from 1985 through 1990 (the highest concentration detected was in MW-10 at 2 µg/L). However, these data were suspected of being unreliable and the groundwater monitoring program was terminated. During this investigation, groundwater samples collected from existing wells were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PAHs, TAL metals, and PCTs.

**Summary of Results.** The following inorganic compounds were detected at concentrations greater than their WRF site background maximum concentrations: aluminum, barium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, selenium, thallium, vanadium, and zinc. Inorganics detected in groundwater above background concentrations in OU1 monitoring wells are presented in Figure 7-6.

The following organic compounds were detected at concentrations below their respective RBCs: 2-methylnaphthalene, acenaphthene, acenaphthylene, acetone, anthracene, alpha-BHC, alpha-BHC, G(Lindane), chrysene, Delta BHC, endosulfan sulfate, and fluoranthene. Most of these compounds were detected at only one sample location. PCBs were not detected in AREE 1 groundwater samples. Total pesticides and total PAHs detected in OU1 groundwater samples are presented in Figure 7-7.

#### 7.2.1.5 Sediment

Eight sediment samples, RISD14 through RISD21, were collected south of AREE 1 along the shore of the Occoquan Bay and west/northwest of AREE 1 in Marumsco Creek. Sediment samples were collected in areas where, based on the drainage patterns at AREE 1, the potential impact of former activities at AREE 1 could be evaluated. Sediment samples were analyzed for TCL VOCs, TCL SVOCs,

pesticides/PCBs, PAHs, TAL metals, and PCTs. The detected concentrations of inorganic and organic compounds in the sediment samples collected near AREE 1 are given in Table 7-10.

**Summary of Results.** No inorganic compounds were detected above site background concentrations in RISD14, RISD15, RISD16, RISD18, or RISD19. The only inorganic compound detected at RISD17 above the WRF site background maximum concentration was silver. Silver was detected at a concentration of 3.45 µg/g in RISD17, while the WRF site background maximum concentration is non-detect. Sodium, vanadium, and zinc were detected above WRF site background maximum concentrations at RISD20. Chromium, cobalt, iron, sodium, and vanadium were detected above WRF site background maximum concentrations at RISD21. Inorganic compounds detected above background in sediment samples are presented in Figure 7-8.

Organic compounds were not detected above their respective RBCs in sediment samples associated with AREE 1, with the exception of the sample collected from RISD20, which had the following organic compounds detected: benzo(a)pyrene - 0.195 µg/g, RBC - 0.088 µg/g; and PCB-1260 - 0.084 µg/g, RBC - 0.083 µg/g. Total PCBs, TPH, pesticides, and PAHs detected in OU1 sediment samples are presented in Figure 7-9.

#### 7.2.1.6 Surface Water

Eight surface water samples, RISW14 through RISW21, were collected in the same locations as the sediment samples for AREE 1. Surface water samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PAHs, TAL metals, and PCTs. Compounds detected in the surface water samples collected in AREE 1 are summarized in Table 7-10.

**Summary of Results.** The following inorganic compounds were detected in surface water samples collected in AREE 1 at concentrations exceeding the WRF site background maximum concentrations: aluminum, barium, chromium, copper, iron, lead, manganese, potassium, vanadium, and zinc. Inorganic compounds detected above background concentrations in surface water are presented in Figure 7-10.

Organic compounds were not detected in the surface water samples associated with AREE 1.

#### 7.2.1.7 Surface Water Runoff

Four surface water runoff samples (SWRO1 through SWRO4) were collected from topographically low areas that receive surface water runoff from AREE 1. Surface water runoff samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PAHs, and PCTs. Sample locations are shown on Figure 7-11. Inorganic and organic compounds detected in the surface water runoff samples collected in AREE 1 are summarized in Table 7-10.

Screening criteria is not available for surface water runoff samples, therefore, the following section lists inorganic and organic compounds detected in surface water runoff samples collected in AREE 1. Inorganics detected in surface water runoff samples from OU1 are presented in Figure 7-11.

**Summary of Results** 2.0.1.8 Summary of Results. The following inorganic compounds were detected in surface water runoff sample SWR01 at the following concentrations: aluminum (6,480 µg/L); arsenic (2.2 µg/L); barium (49.8 µg/L); calcium (58,300 µg/L); chromium (10.0 µg/L); iron (9,980 µg/L); lead (5.5 µg/L); magnesium (10,600 µg/L); manganese (555 µg/L); potassium (2,660 µg/L); sodium (7,740 µg/L); vanadium (16.4 µg/L); and zinc (34.0 µg/L). Benzoic acid was the only organic compound detected in SWR01 at a concentration of 5.2 µg/L.

Inorganic compound concentrations detected in SWR02 include the following: arsenic (4.4 µg/L); aluminum (34,600 µg/L); barium (122 µg/L); cadmium (0.2 µg/L); calcium (27,700 µg/L); chromium (43.8 µg/L); copper (28.0 µg/L); iron (45,200 µg/L); lead (70.2 µg/L); magnesium (8,400 µg/L); manganese (344 µg/L); mercury (0.23 µg/L); nickel (25.8 µg/L); potassium (6,880 µg/L); sodium (5,680 µg/L); thallium (0.3 µg/L); vanadium (87.4 µg/L); and zinc (164 µg/L). Concentrations of organic compounds detected in SWR02 include: anthracene (1.35 µg/L);

benzo(a)pyrene (0.014 µg/L); fluoranthene (0.053 µg/L); PCB-1260 µg/L (0.486 µg/L); and pyrene (0.129 µg/L).

Inorganic compounds detected in SWR03 include the following: aluminum (43,300 µg/L); arsenic (5.6 µg/L); barium (139 µg/L); cadmium (0.3 µg/L); calcium (21,800 µg/L); chromium (53.0 µg/L); copper (28.4 µg/L); iron (48,500 µg/L); lead (47.2 µg/L); magnesium (9,460 µg/L); manganese (603 µg/L); mercury (0.23 µg/L); nickel (22.6 µg/L); potassium (8,500 µg/L); sodium (5,930 µg/L); thallium (0.4 µg/L); vanadium (92.8 µg/L); and zinc (177 µg/L). Organic compounds present in SWR03 above detection limits include: anthracene (2.73 µg/L); benzo(a)pyrene (0.016 µg/L); fluoranthene (0.050 µg/L); PCB-1260 (4.40 µg/L); and pyrene (0.237 µg/L).

Concentrations of inorganic compounds present in SWR04 include the following: aluminum (35,700 µg/L); arsenic (3.4 µg/L); barium (171 µg/L); cadmium (0.3 µg/L); calcium (15,300 µg/L); chromium (60.9 µg/L); copper (33.3 µg/L); iron (57,800 µg/L); lead (42.5 µg/L); magnesium (8,860 µg/L); manganese (498 µg/L); nickel (29.0 µg/L); potassium (7,950 µg/L); sodium (3,260 µg/L); thallium (0.3 µg/L); vanadium (106 µg/L); and zinc (197 µg/L).

Three organic compounds were detected in SWR04 and include anthracene (0.923 µg/L); PCB-1260 (0.224 µg/L); and pyrene (0.151 µg/L). Total pesticides and total PAH concentrations detected in surface water runoff samples from OU1 are presented in Figure 7-12. PCB concentrations detected in surface water runoff samples are presented in Figure 7-2.

#### 7.2.1.8 Discussion

Inorganic compounds were detected at concentrations exceeding the WRF site background maximum concentrations in surface soils, subsurface soils, groundwater, sediment, surface water, and surface water runoff. Zinc concentrations in four of the eight surface soil samples (RISS1, RISS4, RISS55 and RISS56) were considerably elevated (231 µg/g, 135 µg/g, 195 µg/g, and 301 µg/g, respectively), while the site background for zinc is 43.9 µg/g. It is likely that the former landfill contributed to the elevated zinc levels in the soil. Surface water runoff sample concentrations were consistently elevated when compared to respective site background levels for inorganics. Aluminum, iron, and lead were particularly elevated and tended to increase in concentration with proximity to the Occoquan Bay; a trend which may be attributed to the accumulation of metals sorbed to soil transported by runoff. Aluminum, barium, copper, iron, lead, manganese, vanadium, and zinc were detected in one surface water sample (RISW19) in excess of site background levels. This sample was taken in Marumsco Creek near its discharge point into the Occoquan Bay. Its high metals content may be attributable to runoff from AREE 1 or sediment transported from other areas by the creek. In addition, the samples were collected during and just after storm events which may also attribute to the elevated metal concentrations.

PAHs, pesticides, and semi-volatiles were also detected in groundwater, sediment, and surface water runoff samples. Two locations had detectable levels of several compounds: groundwater from MW-77 contained detectable amounts of 2-methylnaphthalene, acenaphthene, chrysene, and fluoranthene, and sediment sample RISD18 contained detectable 2-methylnaphthalene, acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, and chrysene. In addition, surface water runoff samples from SWRO2, SWRO3, and SWRO4 exhibited moderately elevated levels of anthracene and lesser amounts of benzo(a)pyrene and fluoranthene. Anthracene was detected in the groundwater sample collected from MW-79. MW-7 had detected concentrations of acenaphthene and fluoranthene. MW-7 was initially installed as an upgradient monitoring well for AREE 1. The site conceptual model indicated that the shallow groundwater at WRF ultimately discharges to the Belmont/Occoquan Bays. However, the tidal influence on the shallow groundwater system at WRF has not been evaluated, therefore, monitoring well MW-1 may not be truly upgradient of AREE 1. Consequently, the source of the PAHs detected in the groundwater from MW-1 may be AREE 1.

Groundwater flow in AREE 1 is generally north to south, based on the site-wide water level maps (Figure 3-14 and Figure 3-16). This suggests that surface water runoff and groundwater discharge from contaminated areas of AREE 1 may have contributed to the PAH levels in sediment samples collected

along the shore of Occoquan Bay. In addition, since WRF is located in an urbanized area and some of the PAHs detected may be a result of its location within this region. Similarly, pesticides at RISD19, collected at the same location as RISW19 (the site of elevated metals concentrations) may have been transported from sites within AREE 1 or, considering its location in Marumsco Creek, from upgradient locations. DDD and DDE were detected in surface soil sample RISS4 (below their RBCs), which is upgradient and east of the sample location for RISD19.

PCB-1260 was detected in surface and subsurface soil, sediment, and surface water runoff samples. PCB-1260 was also detected in the fish tissue samples described in Section 7.6.4. The detected concentration of PCB-1260 in surface soil samples RISS1 (0.149  $\mu\text{g/g}$ ) and RISS4 (0.713  $\mu\text{g/g}$ ) exceeds the RBC for soil for carcinogenic PCB congeners (0.083  $\mu\text{g/g}$ ). Detected concentrations of PCB-1260 in soil boring MW-80 were 10.8  $\mu\text{g/g}$  at 0 to 2 feet bgs and 1.62  $\mu\text{g/g}$  at 5 to 10 feet bgs, both of which exceed the RBC for soil. The higher concentrations in the subsurface soil samples are most likely due to the disposal of PCBs in this area. A stiff clay layer is present in this area directly below the topsoil to a depth of approximately 4 feet bgs. PCBs would tend to bind to these clays. In addition, MW-78 had a concentration slightly above the RBC and MW-76 had detectable levels of PCB-1260, though less than the RBC. The detected concentration of PCB-1260 in RISD20, collected along Marumsco Creek, was 0.084  $\mu\text{g/g}$  which exceeds the RBC (0.083  $\mu\text{g/g}$ ). Three of the four surface water runoff samples had PCB-1260 concentrations above detection limits with one, SWRO3, at a significantly elevated concentration (4.40  $\mu\text{g/L}$ ). The locations of the contaminated sites, as well as the media contaminated, indicate that, like the PAH contamination, surface water runoff from PCB-1260 contaminated sites within AREE 1 has transported the contaminant downgradient to the vicinity of Occoquan Bay, with possible off-site contributions transported by Marumsco Creek. However, sediment samples collected along the shore of the Bay (near AREE 1) during the 1995 RI field work did not indicate PCB contamination. The results of the VADEQ Bioaccumulation Initiative detected PCB contamination in sediment and soils at comparable locations to those discussed here. The VADEQ study collected a storm water runoff sample, WRF03, in which PCBs were detected. This indicates that PCBs may be discharging to the Occoquan Bay from AREE 1.

### 7.2.1.9 Conclusions

Prior disposal practices at AREE 1 as a landfill have contributed to elevated zinc levels in the surface soil, PAHs in the groundwater, and PCBs in the surface and subsurface soil. Surface water runoff from AREE 1 may have transported contaminants to the Occoquan Bay, although some contamination may be due to upgradient sources (which have most likely been transported via Marumsco Creek). PCBs were not detected in sediment directly along the shoreline from samples collected for the RI, however they have been detected in the Occoquan Bay as well as Marumsco Creek (from previous investigations). In addition, PCBs have been detected in surface and subsurface soils at AREE 1, and surface water runoff samples.

### 7.2.2 AREE 2 and AREE 5

AREEs 2 and 5 are sites of former landfills where transformers (AREE 2), capacitors (AREE 2), and metal debris were buried. These disposal areas are located adjacent to each other, just north of where Lake Drive dead ends as shown in Figure 2-4. Due to the proximity of these AREEs, they have been evaluated as a single source area. Therefore, current sampling locations, both upgradient and downgradient, encompass both AREEs. Results from previous site investigations related to AREEs 2 and 5 are presented below. Figure 3-1 presents the locations of the monitoring wells installed for the RI and Figures 6-3 through 6-6 present the sample locations of all other media sampled for the RI.

### 7.2.3 AREE 2 And AREE 5 Investigation Results

The following sections present sample location methodologies and analytical data resulting from the 1995 RI and conclusions derived from these data. Table 7-11 presents a summary of the RI samples collected for the RI and presents the detected concentrations for all media sampled during the RI for AREEs 2/5.

### 7.2.3.1 Surface Soil

Five surface soil samples (RISS5-9) were collected within and around AREE 5 to characterize the extent of surficial contamination. Soil samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH.

**Summary of Results.** The following inorganic compounds were detected at concentrations which exceed the WRF site background maximum concentrations for these compounds: aluminum, barium, beryllium, copper, lead, manganese, potassium, and sodium. Inorganic compounds detected in surface soils above background concentrations in OU1 are presented in Figure 7-1.

Organic compounds were not detected above their respective RBCs in surface soil samples collected from AREEs 2 and 5.

### 7.2.3.2 Subsurface Soil

Seven shallow soil borings (one upgradient and seven downgradient), located to encompass AREEs 2 and 5, were drilled to identify potential source areas and the extent of contamination in the soil. These soil borings were later converted to monitoring wells MW-68, MW-70 through MW-74, and MW-81. An additional soil boring (RISB6) was installed near the SI sample location (02SW04) where PCBs were detected. Boring logs and monitoring well completion diagrams are presented in Appendix C. Subsurface soil samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PCTs (if PCBs were detected), and TPH. Detected concentrations of inorganic and organic compounds in the subsurface soil samples collected in AREEs 2 and 5 are presented in Table 7-11. The locations of the soil boring/monitoring well are illustrated on Figure 3-1.

**Summary of Results.** Many inorganic compounds were detected above site background levels in subsurface soil samples collected from 0 to 2 feet bgs. Aluminum was detected in the sample from MW-70 at a concentration of 21,000 µg/g (site background concentration is 18,200 µg/g). Barium was detected in the sample from MW-81 at a concentration of 77.4 µg/g (site background concentration of barium is 73.4 µg/g). Beryllium was detected in the sample the sample from MW-71DUP at a concentration of 1.26 µg/g (site background concentration is 1.02 µg/g). Calcium was detected in samples MW-71 (522 µg/g), MW-71DUP (575 µg/g), MW-81 (4,170 µg/g). The site background concentration for calcium is 454 µg/g. Chromium was detected above the site background concentration of 25.0 µg/g in 0 to 2 feet samples collected from MW-70 (29.5 µg/g) and MW-71 (30.6 µg/g). Cobalt was detected above the site background maximum concentration of 13.9 µg/g in two shallow subsurface samples (MW-68 - 20.0 µg/g and MW-71 DUP - 37.5 µg/g). Lead was detected in four shallow subsurface soil samples at concentrations above the site background maximum concentration of 11.8 µg/g in MW-68 (14.6 µg/g), MW-74 (23.6 µg/g), MW-81 (22.4 µg/g), and RISB6 (24.3 µg/g). Manganese was detected in three shallow subsurface soil samples at concentrations of 858 µg/g (MW-68), 684 µg/g (MW-71DUP), and 1,100 µg/g (MW-81), respectively, which are all above the WRF site background maximum concentration of 617 µg/g. Potassium was detected in one sample MW-70 (665 µg/g), above the site background concentration of 624 µg/g. Vanadium was detected in all shallow subsurface soil samples above the vanadium site background concentration of 25.8 µg/g, with the exception of MW-74. Inorganic compounds detected above site background in surface soil samples (0 to 2 feet bgs) collected in OU1 are presented in Figure 7-1.

Inorganic compounds were also detected above site background concentrations in subsurface soil samples collected from 2 feet bgs to the water table. Antimony was detected in the sample collected from the sample collected from MW-71 at a concentration of 0.40 µg/g (site background concentration was non-detect). Calcium was detected in the samples from MW-71 (10-12 feet) at 1,260 µg/g, MW-81 (5-7 feet) at 7,520 µg/g, and MW-81 (10-12 feet) at 2,700 µg/g. The site background concentration for calcium is 454 µg/g. Silver was detected in the sample from MW-70 (5-7 feet) at a concentration of 2.08 µg/g (site background is non-detect). Inorganic compounds detected in subsurface soils above site background concentrations are presented in Figure 7-4.

Several organics were detected above their respective soil RBCs in the subsurface soil samples collected from 0 to 2 feet bgs. PCB-1248 was detected in the sample from MW-81 at 0.22 µg/g (RBC is 0.083 µg/g). PCB-1254 was detected in the sample from MW-81 at 1.00 µg/g (RBC is 0.16 µg/g). TPH as diesel was detected in the sample from MW-74 at 27.9 µg/g (Virginia UST Program Action Level 100 µg/g). TPH as gas was detected in the sample from MW-74 at 9.88 µg/g (Virginia UST Action Level is 100 µg/g).

Organic compounds were also detected in the subsurface soil samples collected from 2 feet bgs to the water table; however only PCBs exceeded their respective soil RBCs. PCB-1248 was detected at 0.36 µg/g and PCB-1254 was detected at 0.16 µg/g in the 10 to 12 feet bgs sample collected from MW-81 (RBC is 0.083 µg/g).

### 7.2.3.3 Test Pits

One test pit (TP3) was excavated in AREE 2 to evaluate the presence of PCB contamination remaining after the 1984 removal action was performed by Weston. One test pit (TP4) was excavated in AREE 5 to characterize the site of a former disposal pit where metal debris is partially buried. Two soil samples were collected from each test pit and analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PCTs (if PCBs were detected), and TPH. Inorganic and organic compounds detected in the samples collected in the test pits for AREEs 2 and 5 are presented in Table 7-11. The locations of the test pits are illustrated in Figure 7-1.

TP3 was trenched in three segments. Segment 1 was cut perpendicular across the previous removal area. The segment was 7 feet long and excavated to a depth of 6 feet bgs. One sample TP3B was collected at 7 feet bgs. Segment 2 also was cut perpendicular to the removal action area. This segment was 15 feet long and excavated to a depth of 9.4 feet bgs. One sample, TP3A, was collected at 9.4 feet bgs. Segment 3 was cut in the northwest/southeast direction between segments 1 and 2. Segment 3 was 18 feet long and excavated to a depth of 9 feet bgs. No sample was collected from Segment 3. Debris consisting of rip-rap and concrete blocks was encountered between 0 - 16 inches below grade in the excavations.

TP4 was excavated in the woods where debris was exposed. TP4 was 52 feet long and excavated to varying depths due to the density of the debris. The depths varied from 3 to 7 feet bgs. Two samples were collected: TP4A at 6 feet bgs and TP4B at 4 feet bgs. The debris consisted of pulleys, cable, pipe, and sheet metal.

**Summary of Results.** Several metals were detected at concentrations exceeding their respective WRF site background maximum concentrations. Inorganics detected include barium detected in TP4A at a concentration of 375 µg/g (WRF site background concentration of 73.8 µg/g), and beryllium detected in test pit samples TP4A and TP4B at concentrations of 2.44 µg/g and 1.08 µg/g, respectively (WRF site background concentration of 1.02 µg/g). Calcium was detected in test pit sample TP4A (8,820 µg/g) and TP4B (535 µg/g). The WRF site background concentration for calcium is 454 µg/g. Chromium was detected in TP3B at a concentration of 26.1 µg/g (site background of 25.0 µg/g). Cobalt was detected in TP4A at a concentration of 23.2 µg/g (WRF site background concentration is 13.9 µg/g). Copper was detected at a concentration of 47.0 µg/g in test pit sample TP4A (WRF site background concentration is 16.9 µg/g). Iron was detected at a concentration of 40,400 µg/g also in sample TP4A, which exceeds the site background level of 27,800 µg/g. Lead exceeded the site background level of 11.8 µg/g in three samples, TP3B, TP4A and TP4B, at concentrations of 12.5 µg/g, 113 µg/g and 18.9 µg/g, respectively. Manganese was detected at a concentration of 3,270 µg/g in TP4A, which exceeds the WRF site background maximum concentration of 617 µg/g. Potassium also exceeded the WRF site background maximum concentration of 624 µg/g in TP3B, TP4A, and TP4B at concentrations of 846 µg/g, 1,230 µg/g, and 892 µg/g, respectively. Sodium was detected at a concentration of 1,190 µg/g in test pit sample TP4A, exceeding the WRF site background maximum concentration of 933 µg/g. Vanadium concentrations exceeded the site background level of 25.8 µg/g in all test pit samples with concentrations ranging from 27.7 µg/g (TP3A) to 49.4 µg/g (TP4B). Zinc was detected at concentrations exceeding WRF site

background maximum concentration of 46.3 µg/g in test pit samples TP4A (416 µg/g) and TP4B (66.2 µg/g). Inorganic compounds detected in subsurface soil samples collected from the test pits are presented in Figure 7-4.

One organic compound, methylene chloride, was detected in three test pit samples, TP3B (0.010 µg/g), TP4A (0.03 µg/g), and TP4B (0.01 µg/g), which are well below the RBC for this compound (85 µg/g). Total pesticide and PAH concentrations detected in shallow (0 to 2 feet bgs) and deeper test pit samples (2 feet bgs) are presented in Figures 7-3 and 7-5, respectively.

#### 7.2.3.4 Groundwater

Seven shallow monitoring wells (MW-68 and MW-70 through MW-74, and MW-81) were installed to investigate potential groundwater contamination associated with AREEs 2 and 5. Soil boring/monitoring well MW-68 serves as an upgradient well due to the screen placement of existing well MW-1. The top of the screen of existing well MW-1 is below the water table, thereby rendering it unable to provide monitoring data for TPH. MW-71 was installed to address the PCB contamination found at former SI sample location 05DP01. MW-81 is located adjacent to existing monitoring wells MW-2 and MW-3 and was completed such that the screens were placed to intercept light phase compounds, if present. In addition, two deep monitoring wells, MW-82 and MW-83 were installed. MW-82 is located adjacent to MW-2 (forming a well cluster with MW-81) to evaluate potential downward migration of PCBs in an area where PCBs have been detected in the past. Deep well, MW-83, was installed to form a well cluster with shallow monitoring well MW-71.

Five of the six existing monitoring wells (MW-1 through MW-5) were resampled during the field investigation for the RI. Monitoring well MW-6 was not sampled due to a damaged well casing which may have compromised the integrity of the sample. Groundwater samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PAHs, TAL metals, PCTs, and TPH in order to further characterize groundwater within AREEs 2 and 5. Inorganic and organic compounds detected in the groundwater samples collected in AREEs 2 and 5 are summarized in Table 7-11.

**Summary of Results.** The following inorganic compounds were detected at concentrations exceeding their respective WRF site background maximum concentrations. Chromium was detected in the sample collected from MW-4 at a concentration of 23.5 µg/L. The site background maximum concentration for chromium is 22.3 µg/L. Iron was detected in groundwater samples collected from MW-5 (14,600 µg/L) and MW-82 (12,500 µg/L). The site background maximum concentrations for iron is 9,620 µg/L. Lead was detected above the WRF site background maximum concentration of 6.3 µg/L in samples collected from the following monitoring wells: MW-1, MW-4, MW-5, and MW-72 at concentrations of 15.9 µg/L, 25.7 µg/L, 15.5 µg/L, and 6.6 µg/L, respectively. Manganese was detected above background in MW-2 and MW-82, and MW-82, Round 2 at concentrations of 388 µg/L, 547 µg/L, and 491 µg/g, respectively (the site background maximum concentration for manganese is 354 µg/L). Nickel was detected in MW-4 at a concentration of 28.1 µg/L (site background concentration of 18.4 µg/L). Thallium was detected in only one sample, MW-4, at a concentration of 0.1 µg/L, which is equal to the site background concentration for thallium. Zinc was detected above the site background concentration of 46 µg/L in samples collected from MW-1 and MW-4, at concentrations of 51 µg/g and 85.4 µg/g, respectively. Inorganic compounds detected in groundwater are presented in Figure 7-6.

All organic compounds were detected at low concentrations below their respective RBCs, with the exception of aldrin detected in MW-82 at a concentration of 0.009 µg/L (RBC of 0.004 µg/L); lindane detected in MW-82 at a concentration of 0.214 µg/L (RBC of 0.052 µg/L); DDT detected in MW-82 at a concentration of 0.051 µg/L (RBC of 0.2 µg/L); heptachlor epoxide, detected in MW-82 at a concentration of 0.035, which is greater than the RBC concentration of 0.0012 µg/L; and PCB-1016, detected in MW-81 at a concentration of 2.93 µg/L, which is greater than the RBC of 0.26 µg/L. Pesticide and semi-volatile plumes have been mapped for this area and are presented as Figures 7-13 and 7-14, respectively. Total pesticides and PAHs detected in groundwater are shown in Figure 7-7.

PAHs and PCBs were detected at low concentrations during the second round of groundwater sampling, conducted in the spring of 1996. The pesticide Aldrin (RBC of 0.004 µg/L) was the only compound detected above the RBC in Round 2 sampling at a concentration of 0.010 µg/L in MW-74 and 0.009 µg/L in MW-82.

#### 7.2.3.5 Sediment

Three sediment samples (RISD11, RISD12, and RISD13) were collected from Marumsco Creek, and from areas topographically downgradient from AREEs 2,5, and AREE 4. All sediment samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PAHs, and PCTs. Analytical results reported for these samples are presented in Table 7-11.

Barium not detected in the sediment samples collected from RISD11, RISD12, and RISD13. Lead was detected in sediment sample, RISD13 at a concentration of 35.3 µg/g which is below the site background concentration of 42.2 µg/g for lead. The following inorganic compounds were present in concentrations above their respective detection limits but below their respective WRF site background concentrations in all three sediment samples: aluminum (site background concentration of 16,900 µg/g); calcium (site background concentration of 6,000 µg/g); chromium (site background concentration of 33.7 µg/g); cobalt (site background concentration of 21.4 µg/g); copper (site background concentration of 44.4 µg/g); iron (site background concentration of 36,500 µg/g); magnesium (site background concentration of 3,740 µg/g); manganese (site background concentration of 1,690 µg/g); nickel (site background concentration of 30.3 µg/g); potassium (site background concentration of 2,120 µg/g); and zinc (site background concentration of 168 µg/g). The beryllium concentration equaled the site background concentration of 1.38 µg/g in RISD12. Sodium concentrations in RISD11 (2,650 µg/g) and in RISD12 (2,450 µg/g) exceeded the WRF site background concentration for sodium of 1,710 µg/g. Vanadium concentrations of 60.9 µg/g and 64.4 µg/g, respectively, exceeded the WRF site background concentration of 54.1 µg/g. Inorganic compounds detected above background concentrations in sediment samples are presented in Figure 7-8.

All organic compounds detected in sediment samples were below RBCs, with the exception of benzo(a)pyrene, detected in RISD12 at a concentration of 0.198 (the RBC for benzo(a)pyrene is 0.198 µg/g). Total pesticides and PAH concentrations detected in sediment samples are presented in Figure 7-9.

#### 7.2.3.6 Surface Water

Three surface water samples RISW11, RISW12, and RISW13, were collected in locations identical to the corresponding sediment sample locations discussed in Section 7.2.3.5. The following inorganic compounds were detected at concentrations below site background concentrations in all three surface water samples (the site background concentrations are given in parenthesis): arsenic (1.4 µg/L); cadmium (non-detect); calcium (22,200 µg/L); chromium (10.8 µg/L); magnesium (7,500 µg/L); manganese (303 µg/L); nickel (non-detect); selenium (non-detect); sodium (16,500 µg/L); thallium (non-detect); and zinc (non-detect).

Inorganics were not detected above WRF site background maximum concentrations in RISW11. Inorganics detected above background concentrations in RISW12 are aluminum (2,100 µg/L, with a site background concentration of 1,930 µg/L); and iron (2,770 µg/L, with a site background concentration of 2,510 µg/L). Inorganics exceeding background concentrations in RISW13 include aluminum (3,460 µg/L); barium (54.3 µg/L); copper (6.1 µg/L); iron (4,110 µg/L); lead (5.2 µg/L); potassium (4,490 µg/L); and vanadium (10.8 µg/L). Inorganics detected above background in surface water samples from OU1 are shown in Figure 7-10.

Organic compounds were not detected above RBCs in surface water samples collected downgradient from AREEs 2, 5, and 4.

#### 7.2.3.7 Surface Water Runoff

Three surface water runoff samples (SWR010, SWR011, and SWR012) were collected from topographically low areas that received surface water runoff from AREEs 2 and 5. Surface water runoff



samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PAHs, and PCTs (if PCBs were detected). Sample locations and detected organic and inorganic compounds/analytes above site background concentrations are presented in Figure 7-11 and 7-12, respectively. A summary of the analytical results of the surface water runoff samples collected from AREEs 2 and 5 are presented in table 7-11.

**Summary of Results.** The following inorganic compounds were detected in surface water runoff sample SWR010 at the following concentrations: aluminum (2,570 µg/L); arsenic (1.2 µg/L); barium (86.3 µg/L); cadmium (0.1 µg/L); calcium (7,020 µg/L); iron (15,800 µg/L); lead (5.3 µg/L); magnesium (4,610 µg/L); manganese (863 µg/L); potassium (1,250 µg/L); sodium (9,720 µg/L); vanadium (12.2 µg/L); and zinc (27.2 µg/L). Two organic compounds, fluoranthene (0.023 µg/L) and endosulfan sulfate (0.105 µg/L), were detected in SWR010 at a concentration of 0.023 µg/L.

Inorganic compounds detected in surface water runoff sample SWR011 area as follows: aluminum (30,200 µg/L); arsenic (2.9 µg/L); barium (178 µg/L); cadmium (0.6 µg/L); calcium (6,880 µg/L); chromium (40.9 µg/L); copper (33.0 µg/L); iron (31,100 µg/L); lead (45.9 µg/L); magnesium (4,640 µg/L); manganese (571 µg/L); nickel (16.1 µg/L); potassium (6,240 µg/L); sodium (1,460 µg/L); thallium (0.4 µg/L); vanadium (82.5 µg/L); and zinc (723 µg/L). The following organic compounds were detected at the following concentrations: DDE (0.012 µg/L); DDT (0.018 µg/L); anthracene (0.161 µg/L); fluoranthene (0.022 µg/L); and pyrene (0.137 µg/L).

SWR012 contained the following inorganic compounds at the following concentrations: aluminum (1,080 µg/L); barium (72.1 µg/L); calcium (6,220 µg/L); iron (20,790 µg/L); lead (1.3 µg/L); magnesium (4,450 µg/L); manganese (1,390 µg/L); potassium (1,920 µg/L); sodium (5,640 µg/L); and zinc (86.0 µg/L). One organic compound, endosulfan sulfate, was detected at a concentration of 0.495 µg/L in surface water sample SWR012.

### 7.2.3.8 Discussion

Inorganic compounds were detected at concentrations exceeding the WRF site background maximum values in surface soil samples (0 - 0.5 feet bgs), shallow soil samples collected from 0 to 2 feet bgs; subsurface soil samples (>2 feet bgs); test pit samples; sediment samples; surface water samples; and groundwater samples. Elevated concentrations of heavy metals were present in surface water runoff samples collected from these AREEs, and in particular, SWR011, which is located on the edge of a wetland area, adjacent to Marumsco Creek. Inorganics of concern which substantially exceeded site background concentrations include aluminum, barium, chromium, cobalt, manganese, nickel and vanadium. Inorganics slightly above site background concentrations include beryllium, copper, lead, and zinc. A substantial portion of the inorganics above site background concentrations were detected from RISS6, RISS7, and RISS8, which are topographically downgradient from AREE 5, where metal debris was supposedly buried in the past. AREEs 2 and 5 are likely contributing to elevated metals concentrations in surface and subsurface soil. Debris uncovered in test pits excavated during the RI could be a possible source for elevated metals contamination in shallow soil samples and groundwater samples.

While organic compounds were not detected in surface soil samples above RBCs, PCB-1248 was detected in subsurface soil samples above RBC concentrations in samples collected from MW-81. MW-82 (installed adjacent to MW-81), was drilled and installed using mud rotary techniques, therefore, no soil samples were collected from this boring.

PAHs and pesticides were detected in groundwater samples above RBCs in both new and existing wells. Figures 7-13 and 7-14 present total pesticides and semi-volatile groundwater plumes associated with these AREEs. The groundwater sample collected from MW-82 (located on the eastern edge of the AREE 2 perimeter) had low levels of multiple PAHs and pesticide compounds, however none of the PAH's were above their respective RBCs. However, two of the pesticides detected had concentrations above their respective RBCs. Heptachlor epoxide (RBC of 0.0012 µg/L) and aldrin (0.004 µg/L) were detected at concentrations of 0.035 µg/L and 0.009 µg/L, respectively. The PAH and pesticides appear to be concentrated mainly in and around AREE 2, with the highest and most frequently detected compounds occurring in samples collected from wells near the southern (downgradient) portion

of AREE 2. AREE 2's history as a former dump may be the source for the PAH/pesticide contamination in this area. PAHs and pesticides were found in surface and subsurface soil samples collected in this area. These PAHs and pesticides may have been leached from the soil and introduced into the groundwater. Methylene chloride (0.010 µg/g) was detected in a test pit sample TP3B collected from AREE 2 at a depth of 7 feet bgs, which is well below the RBC value for methylene chloride of 760 µg/g.

#### 7.2.3.9 Conclusions

Heavy metals are present in surface soils samples above site background levels, particularly in RISS7. Elevated concentrations of metals in shallow soil samples are widespread across AREEs 2 and 5, which may be derived from debris previously disposed of in this area. Although metals were detected in test pit samples within these AREEs, elevated concentrations are more prevalent in surface soils than in subsurface soils. For example, TP4B, collected at 4 feet bgs, had higher and more frequent detects of inorganic analytes than did test pit samples collected from deeper depths. Surface water samples also showed elevated metals concentrations, which could be attributed to metals present in surface soils within AREEs 2 and 5. However, these samples were collected during and after storm events and this may have contributed to the elevated concentrations of metals in surface water.

Metals detected in groundwater were varied and detected in both existing and newly-installed wells in both AREEs. Metals seemed to be more frequently detected in existing wells located in close proximity to AREE 2.

Elevated PAH/pesticide concentrations were detected in groundwater samples collected from these AREEs. The most frequently detected concentrations were collected from MW-81 and MW-82, which are located adjacent to each other, near the eastern (downgradient) edge of AREE 2.

PCBs were detected at low concentrations in the 0 to 2 feet bgs subsurface soil sample collected from MW-81. MW-81 is located within the former landfill (AREE 2), on the eastern side. PCBs were also present in subsurface samples collected from MW-81, as well as the groundwater sample collected during the Round 2 sampling event at a concentration of 2.93 µg/L PCB-1016.

#### 7.2.4 AREEs 3 and 6A Investigation Results

AREEs 3 and 6A are former dumps located in the northern portion of OU1, west of Deephole Point Road and east of Lake Drive. In past documents these AREEs were treated separately, however in view of their close proximity (40 feet) to each other (an ephemeral pond separates the two), these two AREEs have been grouped together and the ephemeral pond has been included in the following discussion. This section presents surface soil and test pit sample data for AREEs 3 and 6A derived from the RI field investigation conducted in 1995. Table 7-12 summarizes the analytical results for the samples collected in AREEs 3 and 6a.

AREE 3 is located just east of the ephemeral pond on the eastside of Lake Drive, and is assumed to be to be approximately 100 feet by 25 feet. The burial of debris such as wood, lead-coated wire, paper, and plastic, reportedly began in 1966, and continued until this area was covered with soil in 1973 (Weston, 1992). AREE 6A is a former dump area located west of Deephole Point Road and south of Lake Drive. This dump was identified by ground scars and soil disturbances observed in aerial photographs, and metal debris has been observed protruding from the toe of the slope along the southwestern extent of AREE 6A. Figure 3-1 presents the locations of the monitoring wells installed for the RI and Figures 6-3 through 6-6 present the sample locations of all other media sampled for the RI.

##### 7.2.4.1 Surface Soil

Three surface soil samples (RISS10-12) were collected for site characterization near AREE 3. These soil samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PAHs, and TAL metals. Analytical results reported for these samples are summarized in Table 7-12.

**Summary of Results - AREE 3:** Several inorganics were detected above WRF site background maximum concentrations in surface soil samples collected from AREE 3. Aluminum was detected at a concentration of 15,500 µg/g in RISS10, which is slightly above the WRF site background level of 14,350 µg/g. RISS10 (12.7 µg/g) was the only surface soil sample that had a concentration above the site background maximum concentration for copper of 12.6 µg/g.

RISS10 (496 µg/g) was above the sodium site background concentration of 487 µg/g and RISS12's (487 µg/g) concentration equaled the site background concentration. Figure 7-1 presents metals concentrations detected above WRF site background maximum concentrations for surface soils, shallow subsurface samples (0 to 2 feet bgs), and shallow test pit samples (0 to 2 feet bgs) for OU1.

Organic compounds were non-detect with the exception of anthracene and methylene chloride. The detection of these organics were both well below their RBCs of 2,300 µg/g and 85 µg/g, respectively. Figure 7-3 presents total PAH and pesticide concentrations detected in surface soils at OU1.

Seven surface soil samples (RISS17 through RISS23) were collected to further characterize AREE 6A. Surface soil samples were collected from areas where stressed vegetation was identified. Soil samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, and PAHs. If PCBs were detected, the laboratory was instructed to analyze for PCTs. Analytical results reported for these samples are summarized in Table 7-12.

**Summary of Results - AREE 6A:** The following inorganic compounds were detected at concentrations below site background levels: barium, calcium, chromium, cobalt, iron, lead, magnesium, manganese, and vanadium. Several inorganic compounds were detected above site background levels. Aluminum was detected at concentrations above site background levels (14,350 µg/g) in RISS22 (16,300 µg/g). Beryllium was detected at concentrations slightly exceeding background for samples in RISS21DUP (0.881 µg/g), and RISS22 (0.825 µg/g). The site background level for beryllium is 0.814 µg/g. Copper was detected at values exceeding the site background value of 12.6 µg/g in RISS21 (16.4 µg/g), RISS21DUP (17.9 µg/g), and RISS22 (16.8 µg/g). The WRF maximum site background concentration for nickel is 11.9 µg/g and the sample RISS21DUP had a nickel concentration of 12.0 µg/g. All surface soil samples analyzed for potassium significantly exceeded the maximum site background level of 936 µg/g. However, potassium is considered an essential nutrient and these levels are not considered significant. Selenium was detected above the maximum background concentration of 14.2 µg/g in the following samples: RISS21 (17.7 µg/g); RISS21DUP (20 µg/g); and RISS22 (24.5 µg/g). Sodium exceeded the site background level of 487 µg/g in samples RISS21 (534 µg/g); RISS21DUP (535 µg/g); RISS22 (544 µg/g); and RISS23 (500 µg/g). One sample, RISS21DUP, exceeded the site background concentration of 43.9 µg/g for zinc, at a concentration of 46.7 µg/g. Figure 7-3 presents metals concentrations detected above WRF site background maximum concentrations for surface soils, shallow subsurface samples (0 to 2 feet bgs) and shallow test pit samples (0 to 2 feet bgs) for OU1.

Aluminum and copper were the only inorganics above site background in both AREEs 3 and 6A (in RISS10, RISS21, RISS21DUP, and RISS22) and both were above background only slightly. These samples locations are nearest the ephemeral pond, located between the two AREEs and surface water runoff from both AREEs appear to drain into the pond.

All organics concentrations detected in surface soil samples collected from both AREEs were below their respective RBC. Total pesticides and PAH detected concentrations for surface soils are presented on Figure 7-3.

#### 7.2.4.2 Subsurface Soil

One shallow soil boring, MW-69 (later converted to a monitoring well), was drilled downgradient of AREE 3 (this boring is also located downgradient of AREE 6A) to further characterize the extent of downgradient subsurface contamination in this area. Boring logs and monitoring well completion diagrams are presented in Appendix C. Subsurface soil samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PAHs, and PCTs (if PCBs were detected). Analytical results reported for these samples are presented in Table 7-12.

**Summary of Results.** Potassium was detected at a concentration of 764 µg/g (site background concentration of 624 µg/g) in the 0 to 2 feet sample of MW-69. Selenium was detected at a

concentration of 15.5 µg/g, which slightly exceeds the site background concentration of 14.2 µg/g in the shallow subsurface soil sample collected from MW-69. All organic concentrations were below their respective RBCs. Two deeper subsurface soil samples (25 to 27 feet bgs and 27-29 feet bgs) were collected from the MW-69 boring, however all inorganic results were below the WRF site background maximum concentrations. No organic compound detections were detected. Figures 7-1, 7-3, 7-4, and 7-5 present inorganic and organic compound concentrations detected in shallow subsurface (0 to 2 feet bgs) and deeper subsurface (>2 feet bgs) soil samples at AREEs 3 and 6A as well as other AREEs within OU1, respectively.

#### 7.2.4.3 Test Pits

Two test pits (TP13 and TP14) were excavated in the AREE 3 former disposal area to characterize this site.

TP13 was trenched in a north/south direction, adjacent to the marsh. TP13 was 47 feet long and excavated to a depth of 7 feet bgs. Two samples were collected: TP13A at 6.5 feet bgs and TP13B at 5 feet bgs. No debris was encountered during the excavation.

TP14 was cut parallel along the western slope in the northeast/southwest direction. TP14 was 49 feet long and excavated to a depth of 7 feet bgs. Two samples were collected: TP14A (TP14A DUP) at 4 feet bgs and TP14B at 7 feet bgs. No debris was encountered during the excavation.

Three test pits (TP15 through TP17) were excavated across the AREE 6A former disposal area to characterize this site.

TP15 was trenched in two segments north of TP16 in order to delineate the aerial extent of debris associated with TP16. Segment 1 was 10 feet long and excavated to a depth of 6 feet bgs. No sample was collected from segment 1. No debris was identified during the excavation of segment 1. Segment 2 was 134 feet long and excavated to a depth of 6 feet bgs. Two samples were collected: TP15A at 1 feet bgs and TP15B at 4 feet bgs. A crushed buried drum and creosote pole were unearthed at 36-inches below grade and black, stained, discolored soil was identified directly underneath the buried drum in segment 2.

TP16 was trenched in two V-shaped segments, south of TP17 and perpendicular to the ditch where debris was identified. Segment 1 was 17 feet long and excavated to a depth of 6 feet bgs. One sample, TP16A, was collected (in duplicate) at 3 feet bgs. Debris consisting of cable and automotive parts were identified between 30 to 37-inches below grade during the excavation. Segment 2 was 20 feet long and excavated to a depth of 5.3 feet bgs. One sample was collected, TP16B, at 3.33 feet bgs. Debris consisting of cable was identified at approximately 35-inches below grade during the excavation.

TP17 was trenched in two segments. Segment 1 was cut into the side of the sloping hill where debris was protruding from the ground. One sample, TP17A, was collected at 6 feet bgs. A length of rebar with cement was unearthed at approximately 72-inches below grade. Segment 2 was cut in an area of stressed vegetation. One sample, TP17B, was collected at the surface.

Summary of Results - AREE 3. Inorganic compounds detected above site background for the test pit samples are shown in Figures 7-1 and 7-4. All inorganic concentrations were below site background maximum concentrations, with the exception of beryllium (1.16 µg/g in sample TP14A); and cobalt (20.3 µg/g in sample TP13A) and cobalt (21.5 µg/g in sample TB-13B). The site background maximum concentration for beryllium is 1.02 µg/g and the site background concentration for cobalt is 13.9 µg/g. Calcium exceeded the WRF site background maximum concentration of 454 µg/g in TP13A, at a concentration of 489 µg/g. Lead concentrations were above the site background level of 11.8 µg/g in two samples, TP14A (12.1 µg/g) and TP14 DUP (13.9 µg/g). Potassium concentrations were below the site background concentration of 624 µg/g with the exception of TP13A (647 µg/g) and TP13B (535 µg/g). Vanadium (site background of 25.8 µg/g) was detected in TP13A at a concentration of 28.9 µg/g and in TP14A at a concentration of 4.0 µg/g.

Organic compounds were not detected above RBCs in test pit samples collected from AREE 3.

**Summary of Results - AREE 6A.** Inorganic compounds detected at concentrations below site background levels include arsenic, beryllium, manganese, and sodium. Inorganics which are above site background concentrations include: aluminum, antimony, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, nickel, potassium, vanadium, and zinc. No organics were detected above RBCs in test pit samples collected in AREE 6A.

#### 7.2.4.4 Sediment

One sediment sample, RISD10, was collected adjacent to the western edge of the ephemeral pond that is between AREEs 3 and 6A. This sample was collected just north of the approximate boundary of AREE 3, at the edge of a ephemeral pond approximately 100 feet southeast of the perennial pond bordering Lake Drive.

**Summary of Results.** The following inorganic compounds were present above detection limits, but below their respective site background concentrations: aluminum (13,200 µg/g - site background of 15,200 µg/g); barium (85.2 µg/g - site background of 175 µg/g); beryllium (0.747 µg/g - site background of 1.26 µg/g); calcium (989 µg/g - site background of 6,000 µg/g); chromium (25 µg/g - site background of 30.1 µg/g); cobalt (8.97 µg/g - site background of 20.7 µg/g); copper (19.6 µg/g - site background of 41.8 µg/g); iron (13,800 µg/g - site background of 34,200 µg/g); lead (16.4 µg/g - site background of 42.2 µg/g); magnesium (2,600 µg/g - site background of 3,740 µg/g); manganese (92.8 µg/g - site background of 1,690 µg/g); nickel (14.7 µg/g - site background of 30.0 µg/g); potassium (1,130 µg/g - site background of 2,120 µg/g); sodium (657 µg/g - site background of 1,710 µg/g); vanadium (37.1 µg/g - site background of 52.5 µg/g); and zinc (72.5 µg/g - site background of 157 µg/g). Inorganic compounds detected above background in the AREEs within OU1 sediments are shown in Figure 7-8. Organic compounds were not detected above RBCs in sediment sample collected from AREE 3..

The only organics detected in RISD10 were benzo(k)fluoranthene at a concentration of 0.002 µg/g - RBC of 8.8 µg/g; anthracene at a concentration of 0.031 µg/g - RBC of 2,300 µg/g; benzo(a)pyrene at a concentration of 0.002 µg/g - RBC of 0.088 µg/g; benzo(b)fluoranthene at a concentration of 0.004 µg/g - RBC of 0.88 µg/g; and fluoranthene at a concentration of 0.006 µg/g - RBC of 310 µg/g. Total PCBs, TPH, pesticides, and PAHs detected in OU1 sediments are shown in Figure 7-11.

#### 7.2.4.5 Surface Water

One surface water sample, RISW10, was collected at the same location as RISD10. The following inorganics were detected at concentrations above their detection limits, but below WRF site background levels: aluminum (547 µg/L - site background of 1,930 µg/L); calcium (2,020 µg/L - site background of 22,200 µg/L); iron (705 µg/L - site background of 2,510 µg/L); magnesium (1,250 µg/L - site background of 7,500 µg/L); manganese (28.3 µg/L - site background of 303 µg/L); potassium (2,010 µg/L - site background of 3,670 µg/L); and sodium (1,380 µg/L - site background of 16,500 µg/L). Inorganics detected above background in surface water are presented as Figure 7-12.

Organic compounds were not detected in RISW10.

#### 7.2.4.6 Groundwater

One monitoring well, MW-69 was installed downgradient of AREEs 3 and 6A). The groundwater samples (Round 1 and Round 2) were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PAHs, PCTs (Round 1 only), TAL metals, and TPH.

**Summary of Results.** The following inorganic compounds exceeded the WRF maximum site background concentrations: iron (25,000 µg/L) the WRF site background maximum concentration is 9,620 µg/L; manganese (641 µg/L) the WRF maximum site background concentration for manganese is 354 µg/L; selenium (4.7 µg/L) the WRF site background maximum concentration for selenium is 4.2 µg/L. Inorganic compounds detected in groundwater above background in OU1 are presented as Figure 7-6.

Anthracene and bis(2-ethylhexyl)phthalate were detected in the groundwater sample collected from MW-69. Anthracene was detected at a concentration of 0.25 µg/L (Round 1 only) in the groundwater sample (RBC for anthracene is 1,100 µg/L). Bis(2-ethylhexyl)phthalate was detected at a concentration of 2.4 µg/L during Round 1 and 4.3 µg/L for Round 2 (RBC for bis(2-ethylhexyl)phthalate is 4.8 µg/L). Heptachlor was detected at a concentration of 0.011 µg/L during the Round 2 sampling event. Pesticides and PAHs detected in groundwater are illustrated on Figure 7-7.

#### 7.2.4.7 Surface Water Runoff

Two surface water runoff samples (SWR05 and SWR09) were collected from topographically low areas that receive surface water runoff from AREE 6A. SWR09 is also topographically downgradient from AREE 3. Surface water runoff samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PAHs, TAL metals, TPH, and PCTs (if PCBs were detected). Sample locations are shown on Figure 7-11. This figure also presents inorganic compounds detected.

**Summary of Results.** The following inorganic compounds were detected in SWR05 at the following concentrations: aluminum (19,200 µg/L); arsenic (1.5 µg/L); barium (147 µg/L); cadmium (1.0 µg/L); calcium (6,130 µg/L); chromium (32.1 µg/L); copper (65.9 µg/L); iron (21,700 µg/L); lead (21.9 µg/L); magnesium (5,260 µg/L); manganese (251 µg/L); nickel (29.8 µg/L); potassium (4,400 µg/L); sodium (5,930 µg/L); thallium (0.3 µg/L); vanadium (55.3 µg/L); and zinc (456 µg/L). Three organic compounds, anthracene, fluoranthene, and pyrene were detected at the following concentrations, respectively: 2.52 µg/L, 0.033 µg/L, and 0.224 µg/L. Total pesticide and PAH concentrations detected in surface water runoff samples are presented in Figure 7-12.

Inorganic compounds were detected in surface water sample SWR09 at the following concentrations: aluminum (12,800 µg/L); barium (55.3 µg/L); cadmium (0.1 µg/L); calcium (4,160 µg/L); chromium (20.1 µg/L); copper (12.0 µg/L); iron (15,100 µg/L); lead (8.5 µg/L); magnesium (3,740 µg/L); manganese (3,740 µg/L); potassium (2,940 µg/L); sodium (5,680 µg/L); thallium (0.2 µg/L); vanadium (36.0 µg/L); and zinc (51.3 µg/L). Organic compounds were not detected in SWR09.

#### 7.2.5 Discussion

Several inorganics (aluminum, copper, manganese, and sodium) were detected slightly above site background concentrations in surface soil samples. Most of these were detected in RISS10, which was collected near the southeastern perimeter of AREE 3. RISS11 was collected in the central portion of AREE 3, and RISS12 was collected in the northwestern portion of the AREE. Test pit subsurface soil samples showed concentrations above site background maximum concentrations with respect to calcium, cobalt, lead, potassium, and vanadium. Beryllium was also detected slightly above site background maximum concentrations in one test pit sample, TP14A, at a depth of 4 feet bgs; however, the concentration is only slightly above background and appears to be highly localized. Vanadium and lead were also present above background in TP14A, which was collected near the suspected dump area, as was RISS10, which exhibited slightly elevated inorganic concentrations.

Two organic compounds were detected in surface soil samples at significantly lower concentrations than their respective RBCs. Both compounds, anthracene (PAH) and methylene chloride (VOC - a common laboratory contaminant), were present in extremely low concentrations, however, they were not detected in test pit samples collected within this AREE. The presence of these compounds may be due to surface water runoff from areas north of AREE 3. In general, PAHs are ubiquitous across the site. The WRF is located in a highly urbanized area and the presence of PAHs may be attributed to its location.

Two inorganic compounds, manganese and selenium, were detected above background concentrations in the groundwater sample collected from MW-69. Anthracene and bis(2-ethylhexyl)phthalate were detected in the groundwater sample collected from MW-69. Heptachlor was detected at a concentration of 0.011 µg/L during the Round 2 sampling event.

Inorganic compounds were detected in surface soil samples in AREE 6A that exceeded site background levels for the following: aluminum, beryllium, copper, nickel, potassium, selenium, sodium, and zinc. Most of these analytes were detected in RISS21 and RISS22, which are located in the southern (topographically downgradient) portions of AREE 6A, near the former dump area southeast of Lake Drive. Selenium was detected in MW-69 at concentrations above site background concentrations. Copper and sodium were detected in the 0 to 2 feet surface soil sample collected from the soil boring in which MW-65 was installed. MW-65 is located approximately 150 feet south of AREE 6A.

Inorganics were detected above site background maximum concentrations in test pit samples collected at depths ranging from 1 to 6 feet bgs from TP15, TP16, and TP17 (AREE 6A). These concentrations may be attributed to the metal debris that was disposed of in this area.

No organic compounds were detected at concentrations exceeding respective RBCs in surface soil samples. Semi-volatiles (PAHs) were detected in shallow soils at low concentrations, with the most frequently detected compounds present in the RISS19 sample, located in the southeastern portion of AREE 6A. Low levels of several PAHs were detected test pit sample, TP16B, collected at a depth of 3.33 feet bgs. TP16 is the most downgradient of the test pits excavated within this AREE. Anthracene was detected at a concentration of 0.25 µg/L in the groundwater sample collected from MW-69.

## 7.2.6 Conclusions

Soils (surface and subsurface) in AREE 3 contain low levels of metals and one PAH (anthracene) and one volatile (methylene chloride). The primary metals of concern are aluminum, beryllium, copper, and lead; however, these metals are present very low concentrations when compared to site background maximum concentrations. Anthracene and methylene-chloride were detected in soils at concentrations well below their respective RBCs.

The inorganics detected in groundwater above site background concentrations are manganese and selenium. Low levels of pesticides and PAHs were detected in the groundwater samples collected from MW-69. The pesticide source is not known but it may be due to past use at the facility.

Surface water runoff samples were not collected from AREE 3, so no determinations can be made concerning contaminant migration through erosion via surface water flow patterns.

## 7.2.7 AREE 4

AREE 4 is a former dump site where debris, such as wire, wood, concrete, pipe insulation, and empty oil drums, were dumped from the late 1950s until 1973 when the dump was covered with dirt (Weston, 1992).

## 7.2.8 AREE 4 Investigation Results

Figure 3-1 presents the locations of the monitoring wells installed for the RI and Figures 6-3 through 6-6 present the sample locations of all other media sampled for the RI. Analytical results for detected chemical compounds for all media sampled for AREE 4 are summarized in Table 7-13.

### 7.2.8.1 Surface Soil

Four soil samples (RISS13-16) were collected for site characterization to determine the extent of surficial contamination associated with AREE 4. The soil samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs (if PCBs were detected), and TPH. See Table 7-13 for inorganics and organics compounds detected in the surface soil samples collected.

**Summary of Results.** The following inorganics had concentrations above detection limits but below WRF site background maximum concentrations for each inorganic compound: aluminum; beryllium; calcium; chromium; cobalt; copper; iron; magnesium; manganese; nickel; potassium; vanadium; and zinc. Only two inorganic compounds, lead and sodium, were detected at levels that exceeded the WRF site background maximum concentrations. Lead was detected slightly above the site background concentration of 22.4 µg/g in surface soil samples RISS13 and RISS14 at concentrations of 22.5 µg/g and 22.7 µg/g, respectively. Sodium was detected above the site background concentration of 487 µg/g, in RISS14 and RISS16, at concentrations of 505

µg/g and 490 µg/g, respectively. Inorganics detected in surface soil samples above background in OU1 are presented in Figure 7-1.

While many organics were detected in surface soil samples RISS13 through RISS16, all organic concentrations were below their RBCs. Total pesticides and PAHs detected in surface soils in OU1 are presented in Figure 7-3.

#### 7.2.8.2 Subsurface Soil

Four soil borings were installed around the previously-trenched area and later converted to monitoring wells. MW-65 was installed to the west and approximately 200 feet upgradient of AREE 4. However, the sample results for MW-65 are presented in this section. These soil borings were designed to evaluate the extent of subsurface soil contamination in downgradient areas associated with this AREE. Boring logs and monitoring well completion diagrams are presented in Appendix C. All subsurface soil samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PCTs (if PCBs were detected), and TPH.

**Summary of Results.** All inorganic compounds analyzed from soil samples collected from 0 to 2 feet bgs had concentrations above detection limits, but below WRF site background maximum concentrations.

Barium, calcium, chromium, cobalt, copper, magnesium, nickel, potassium, vanadium, and zinc were detected slightly above site background concentrations in the 15 feet bgs sample collected from the soil boring in which MW-64 was installed. The remaining compounds analyzed from samples collected from 2 feet bgs to the water table were detected at concentrations below site background for each respective inorganic compound. Two inorganic compounds, copper and sodium, were detected above WRF site background maximum concentrations in MW-65 (0 to 2 feet bgs) and the duplicate sample collected from this boring (MW-65DUP). The WRF site background maximum concentration for copper is 12.6 µg/g and for sodium is 487 µg/g. Inorganics detected above background in subsurface (> 2 feet bgs) soil samples at OU1 are presented in Figure 7-4.

Organic compounds were not detected above RBCs for shallow (0 to 2 feet bgs) soil samples collected from borings in AREE 4, with the exception of benzo(a)pyrene, detected at a concentration of 0.22 µg/g in MW-65 (site background concentration of 0.088 µg/g). No organic compounds were detected above RBC values for subsurface soil samples collected at depths from 0 to 2 feet bgs.

Organic compound concentrations in subsurface soil samples collected from 2 feet bgs to the water table were below respective RBCs. Total pesticides and PAHs detected in subsurface soil samples collected in OU1 are shown in Figure 7-5.

#### 7.2.8.3 Test Pits

Test pits were excavated to evaluate eight geophysical anomalies previously identified in AREE 4. TP5 through TP12 were excavated to locate buried debris and to ascertain whether subsurface contamination was present. The locations of the test pits are presented in Figure 7-1. TP10 through TP12 were excavated in the area between AREES 6A and 4 along a dirt road where debris has been identified. The remaining test pits were excavated in the wooded area within AREE 4. Two soil samples were collected from each test pit and were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PCTs (if PCBs were detected), and TAL metals. Analytical results of samples collected from the test pits are summarized in Table 7-13. Test pit locations, lateral extent, and depths are discussed below:

TP5 was excavated parallel to the dirt road running north/south where hoses which contain wiring protruded from the ground surface, west of AREE 4. TP5 was 31 feet long and excavated to a depth of 6 feet bgs. Two samples were collected: TP5A at 5.75 feet bgs and TP5B at ground surface. Debris was not encountered during the excavation of the test pit.

TP6 was excavated in three segments east of the dirt road where surficial debris was located. Segment 1 was 12 feet long and excavated to a depth of 6 feet bgs. One sample was collected at 5.6 feet bgs. Debris was not encountered during the excavation of the test pit.



TP7 was excavated downgradient of geophysical anomalies identified during the SI (USAEC, 1995c). TP7 was trenched with an east/west orientation; was 21 feet long, and was excavated to a depth of 6.5 feet bgs. Two samples were collected: TP7A at the surface and TP7B at 6.66 feet bgs. Debris was not encountered during the excavation of the test pit.

TP8 was excavated east of TP7 with an east/west orientation. TP8 was 25 feet long and was excavated to a depth of 8 feet bgs. Two samples were collected: TP8A at 8 feet bgs and TP8B at 6.5 feet bgs. Debris was not encountered during the excavation of the test pit.

TP9 was excavated in two segments. Segment 1 was trenched parallel to and southwest of TP11. TP9 was 15 feet long and excavated to a depth of 7 feet bgs. One sample was collected in duplicate, TP9A at 7 feet bgs. Segment 2 was parallel to and southeast of Segment 1. Segment 2 was 23 feet long and excavated to a depth of 8 feet bgs. One sample (TP9B) was collected at 8 feet bgs. Debris was not encountered during the excavation of the test pit.

TP10 was trenched west of TP12. TP10 was 24 feet long and excavated to a depth of 8 feet bgs. Two samples were collected: TP10A at 8 feet bgs and TP10B at the surface. Debris was not encountered during the excavation of the test pit.

TP11 was trenched south of the road where rubber-coated hoses containing wire were observed. TP11 was 20 feet long and excavated to a depth of 7 feet bgs. Two samples were collected: TP11A at 7 feet bgs and TP11B at the surface. Debris was not encountered during the excavation of the test pit.

TP12 was trenched in four segments cutting into the hillside on the north side of the road. Segment 1 was 11 feet long by 7 feet bgs. One sample, TP12B was collected at 7 feet bgs. Segment 2 was 12 feet long and excavated to a depth of 7 feet bgs. No sample was collected from segment 2. Segment 3 was 11 feet long and excavated to a depth of 7 feet bgs. No sample was collected from segment 3. Segment 4 was 11 feet long and excavated to a depth of 7 feet bgs. One sample, TP12A, was collected at the surface. Debris was not encountered during the excavation of the test pit.

Summary of Results. Aluminum was present in concentrations slightly exceeding site background maximum concentration of 14,350  $\mu\text{g/g}$  for samples collected from 0 to 2 feet bgs as follows: TP10B (15,100  $\mu\text{g/g}$ ), TP11B (14,700  $\mu\text{g/g}$ ), and TP12A (15,900  $\mu\text{g/g}$ ). TP8B (6.5 feet bgs) had an aluminum concentration of 18,600  $\mu\text{g/g}$ , which is slightly above the WRF site background maximum concentration of 18,200  $\mu\text{g/g}$ . Barium was detected in three samples: TP8B (222  $\mu\text{g/g}$ ), TP9B (116  $\mu\text{g/g}$ ), and TP11B (103  $\mu\text{g/g}$ ), all of which exceeded site background concentrations of 92.4  $\mu\text{g/g}$  (site background level for samples collected from 0 to 2 feet bgs) and 73.8  $\mu\text{g/g}$  (site background level for samples collected at or below 2 feet bgs). Beryllium was detected above the site background concentration level for samples collected from 0 to 2 feet bgs (0.814  $\mu\text{g/g}$ ) in TP7A at 0.916  $\mu\text{g/g}$ , in TP10B at 0.859  $\mu\text{g/g}$ , in TP11B at 1.30  $\mu\text{g/g}$ , and in TP12A at 0.871. Beryllium was detected above site background concentrations for samples collected from 2 feet bgs to the water table (1.02  $\mu\text{g/g}$ ) in TP6A at 1.25  $\mu\text{g/g}$ , in TP8B at 1.44  $\mu\text{g/g}$ , in TP12B at 1.37  $\mu\text{g/g}$ . Chromium was not detected above site background concentrations (31.3  $\mu\text{g/g}$ ) for samples collected from 0 to 2 feet bgs. Chromium was detected above the site background concentrations for samples collected from 2 feet to the water table at 25.0  $\mu\text{g/g}$  in TP6A at 31.1  $\mu\text{g/g}$ ; in TP7B at 26.7  $\mu\text{g/g}$ ; in TP8B at 40.8  $\mu\text{g/g}$ ; in TP9B at 40.1  $\mu\text{g/g}$ ; in TP11A at 26.8  $\mu\text{g/g}$ ; and in TP12 B at 31.6  $\mu\text{g/g}$ . Cobalt was detected above the site background concentration of 16.6  $\mu\text{g/g}$  for samples collected from 0 to 2 feet bgs in TP11B at 29.0  $\mu\text{g/g}$ . Cobalt was detected above the site background concentration for samples collected from 2 feet bgs to the water table of 13.9  $\mu\text{g/g}$  in TP6B at 15.3  $\mu\text{g/g}$  and in TP9B at 22.9  $\mu\text{g/g}$ . Copper was detected above the site background concentration of 12.6  $\mu\text{g/g}$  for samples collected from 0 to 2 feet bgs in TP10B at 14.4  $\mu\text{g/g}$  and in TP11 at 100  $\mu\text{g/g}$ . Copper was detected above the site background concentration of 16.9  $\mu\text{g/g}$  for samples collected from 2 feet bgs to the water table in TP8B at a concentration of 27.8  $\mu\text{g/g}$  in TP9B at 27.4, and in TP12B at a concentration of 22.0  $\mu\text{g/g}$ . Iron was detected above the site background concentration for samples collected from 0 to 2 feet bgs of 28,100  $\mu\text{g/g}$  in TP11A at 36,700  $\mu\text{g/g}$ , in TP11B at 31,500  $\mu\text{g/g}$ , and in TP12A at 31,200  $\mu\text{g/g}$ . Iron was detected above the site background concentration for samples

collected from 2 feet bgs to the water table of 27,800 µg/g in TP10A at 31,900 µg/g. Lead was not detected above the site background concentration in samples collected from 0 to 2 feet bgs. Lead was detected above the site background ( 11.8 µg/g) for samples collected from 2 feet to the water table in TP5A at 17.3 µg/g, in TP7B at 14.3 µg/g, in TP8B at 12.4 µg/g, in TP9B at 12.6 µg/g, and in TP12B at 14.8 µg/g. Magnesium was detected above the site background concentration (2,610 µg/g) in samples collected from 0 to 2 feet bgs in TP11B at a concentration of 3,770 µg/g. Magnesium was detected above the site background concentration for samples collected from 2 feet bgs to the water table in TP8B at 5,250 µg/g, and in TP9ADUP at 5,870 µg/g. Nickel was detected above the site background concentration of 11.9 µg/g for samples collected from 0 to 2 feet bgs in TP11B at a concentration of 19.2 µg/g. Nickel was detected above the site background concentration of 17.9 µg/g for samples collected from 2 feet bgs to the water table in TP8B at a concentration of 31.3 µg/g and in TP9B at a concentration of 9.8 µg/g. Potassium was not detected above the site background concentrations of 936 µg/g in the samples collected from 0 to 2 feet bgs. Potassium was detected above the site background concentration for samples collected from 2 feet to the water table of 624 µg/g in TP6A at 1,010 µg/g, in TP7B at 966 µg/g, in TP8B at 1,340 µg/g, in TP9B at 1,030 µg/g, in TP11A at 952 µg/g, and in TP12A at 815 µg/g. Sodium was detected above the site background concentration for samples collected from 0 to 2 feet bgs of 487 µg/g in TP7A and in TP11B at 700 µg/g. Sodium was detected above the site background concentration of 933 µg/g for samples collected from 2 feet bgs to the water table in TP8B at 996 µg/g and in TP9B at 1,540 µg/g. Vanadium was not detected above the site background concentration of 58.9 µg/g in samples collected from 0 to 2 feet bgs. Vanadium was detected above the site background concentration of 25.8 µg/g for samples collected from 2 feet bgs to the water table in TP5A at 29.6 µg/g; in TP5B at 47.5 µg/g; in TP7B at 38.0 µg/g; in TP8B at 66.7 µg/g; in TP9B at 64.9 µg/g; in TP10A at 30.7 µg/g; in TP11A at 28.3 µg/g; and in TP12B at 62.3 µg/g. Zinc was detected above the site background concentration for samples collected from 0 to 2 feet bgs of 43.9 µg/g in TP11A at 49.2 µg/g. Zinc was detected above the site background concentration of 46.3 µg/g for samples collected from 2 feet bgs to the water table in TP8B at 61.4 µg/g; in TP9B at 73.0 µg/g ;and in TP12B at 57.6 µg/g.

Inorganic compounds detected in test pit samples above background concentrations are presented in Figures 7-1 (surface soils) and 7-4 (subsurface soils).

Organic compounds were not detected above RBC concentrations in test pit samples collected in AREE 4.

#### 7.2.8.4 Groundwater

Three monitoring wells, one upgradient (MW-64), and two downgradient (MW-66 and MW-67), were installed around the previously trenched area discussed earlier. An additional well, MW-65, was installed upgradient, approximately 200 feet west of AREE 4. These wells were designed to evaluate upgradient groundwater quality and the extent of groundwater contamination in downgradient areas associated with this AREE. Groundwater samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PAHs, PCTs (if PCBs were detected), TPH, and TAL metals. Detected concentrations for groundwater samples collected in AREE 4 are presented in Table 7-13.

Summary of Results. Inorganics were detected in groundwater samples collected from AREE 4. Arsenic was detected at a concentration of 3.1 µg/L in the sample collected from MW-67, however the concentration did not exceed the site background maximum concentration of 6.70 µg/L. Cobalt was detected at in the sample from MW-67 (32.3 µg/L) and the Round 2 MW-67 sample (24.3 µg/L). The site background maximum concentration for cobalt is non-detect. Iron exceeded the site background maximum concentration (9,620 µg/L) in the sample collected from MW-67 at a concentration of 10,500 µg/L. Manganese was detected in MW-67 (4,670 µg/L) and in MW-64 (490 µg/L) which exceeded the WRF site background concentration of 354 µg/L.

Several inorganics were detected at concentrations below WRF site background maximum concentrations in the sample collected from MW-65. These inorganics are: aluminum, arsenic,

barium, calcium, chromium, cobalt, iron, lead, manganese, nickel, potassium, sodium, and zinc. Only two inorganic compounds, magnesium and selenium, were detected above site background concentrations. Inorganic compounds detected in groundwater samples collected from OU1 are presented in Figure 7-6.

Organic compounds were not detected in the groundwater samples collected in AREE 4.

#### 7.2.8.5 Surface Water Runoff

Two surface water runoff samples (SWR06 and SWR07) were collected from topographical low areas that receive surface water runoff from AREE 4. Surface water runoff samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PAHs, and PCTs (if PCBs were detected).

Summary of Results. The following inorganic compounds were detected in SWR06: aluminum (9780 µg/L); barium (78.2 µg/L); cadmium (0.2 µg/L); calcium (4,480 µg/L); chromium (14.0 µg/L); copper (7.1 µg/L); iron (10,900 µg/L); lead (15.9 µg/L); magnesium (2,760 µg/L); manganese (187 µg/L); potassium (3,280 µg/L); sodium (2,540 µg/L); thallium (0.1 µg/L); vanadium (30.0 µg/L); and zinc (42.5 µg/L). Two organic compounds, anthracene and fluoranthene, were detected in SWR06 at concentrations of 0.485 µg/L and 0.029 µg/L, respectively.

Inorganic compounds and their detected levels for SWR07 are as follows: aluminum (7,010 µg/L); barium (138 µg/L); cadmium (0.5 µg/L); calcium (6,160 µg/L); chromium (11.5 µg/L); cobalt (21.6 µg/L); copper (9.8 µg/L); iron (12,300 µg/L); lead (25.4 µg/L); magnesium (5,520 µg/L); manganese (321 µg/L); nickel (19.3 µg/L); potassium (2,620 µg/L); selenium (2.3 µg/L); sodium (13,600 µg/L); thallium (0.1 µg/L); vanadium (27.4 µg/L); and zinc (112 µg/L). Organic compounds detected in SWR07 include DDD (0.010 µg/L); DDT (0.009 µg/L); anthracene (3.80 µg/L); fluoranthene (0.044 µg/L); and pyrene (0.214 µg/L).

Inorganic compounds detected above site background concentrations and total pesticides and PAHs detected in surface water runoff samples from OU1 are shown in Figures 7-11 and 7-12, respectively.

#### 7.2.9 Discussion

Metals are present in surface soil samples collected within this AREE. As mentioned earlier, lead was detected at concentrations exceeding site background concentrations. Lead detected in this area most likely resulted from surface water runoff from leaching of debris disposed of in this area. The surface water runoff in this area ultimately discharges to Marumsco Creek.

Subsurface soil samples indicate slight metals contamination in the soil boring in which MW-64 was installed. MW-64 is located just outside the AREE 4 perimeter, on the southeastern side of the AREE. Most of the metals detected above background concentrations were detected in the subsurface soil sample collected at the 15 to 17 foot interval, which is within the screened interval for this well. However, metals concentrations in the groundwater sample collected from MW-64 were below the maximum WRF site background concentrations, with the exception of manganese. There is a silty clay to clay layer present at this depth (a sandy layer is directly below the clay in which the screen is partially set) which could retard the leaching of metals into the groundwater. Sodium and copper were detected above WRF site background maximum concentrations in upgradient shallow soil samples and magnesium and selenium were detected in an upgradient groundwater sample (MW-65) above site background maximum concentrations.

Aluminum, barium, beryllium, chromium, cobalt, copper, iron, lead, magnesium, nickel, potassium, sodium, vanadium, and zinc were detected at concentrations exceeding site background maximum concentrations in test pit samples (TP5 through TP12). The test pits were all excavated in southern (topographically and potentiometrically downgradient) areas of AREE 4, with the exception of TP5, which was located in the eastern central portion of AREE 4. Metals concentrations in TP5 samples were below site background concentrations, with the exception of calcium and vanadium, detected in the TP5A sample collected at 5.75 feet bgs.

Inorganic compounds detected in groundwater exceeded site background concentrations most frequently in the sample collected from MW-67, which is a downgradient well for AREE 4. The screened interval for this well is set partially in silt and clayey silt, partially in silty sand, and partially in sand, as opposed to predominantly sand, in which MW-66 is set. The lower concentrations and number of metals detected in MW-66 may be attributed to the higher permeability in which the well is screened that may increase the dilution of metals in the more permeable lithologies.

#### 7.2.10 Conclusions

Metals which slightly exceed background levels were detected in surface soil, subsurface soil, and groundwater in AREE 4. Heavy metals including lead, chromium, copper, nickel, and zinc, detected in groundwater samples, have the potential to impact Marumsco Creek, as groundwater within this area generally discharges to Marumsco Creek. No significant organic compounds were detected in AREE 4.

#### 7.2.11 AREE 6B Investigation Results

AREE 6B is a former dump located at the intersection of Deephole Point Road and Shady Road across from AREE 1 (refer to Figure 2-4). It was identified based on ground scars and soil disturbances identified on aerial photographs for the facility taken in the 1960s and 1970s (USAEC, 1995e).

Figure 3-1 presents the locations of the monitoring wells installed for the RI and Figures 6-3 through 6-6 present the sample locations of all other media sampled for the RI. Analytical results from these samples are discussed in the following sections. Analytical results for the compounds detected for each media sampled are summarized in Table 7-14.

##### 7.2.11.1 Surface Soil

One surface soil sample was collected for site characterization (RISS24) and analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH. RISS24 was collected from the north central portion of AREE 6B. Sample locations for soil boring/monitoring wells, surface soil samples and test pit locations for this RI are presented in Figure 7-1.

Summary of Results. The following inorganic compounds were detected at concentrations exceeding the maximum WRF site background concentrations in RISS24: aluminum (15,400 µg/g; - site background concentration of 14,350 µg/g); beryllium (0.857 µg/g; site background concentration of 0.814); copper (15.5 µg/g, site background concentration of 12.6 µg/g); iron (37,300 µg/g, site background concentration of 28,100 µg/g); and selenium (17.8 µg/g, site background concentration of 14.2 µg/g). Inorganics detected above background concentrations in surface soils are shown on Figure 7-1.

Organics were not detected in the surface soil sample.

##### 7.2.11.2 Subsurface Soil

A soil boring/monitoring well MW-60 was installed upgradient of this AREE (which is also upgradient of AREE 7) to evaluate groundwater quality in this area. Soil boring/monitoring well, MW-75, was installed downgradient from AREES 6B and AREE 7 to evaluate groundwater quality and subsurface soil conditions in this area. Boring logs and monitoring well completion diagrams are presented in Appendix C. Subsurface soil samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, and TPH.

Summary of Results. No inorganic compounds were detected above WRF site background concentrations in shallow subsurface soil samples collected from 0 to 2 feet bgs in AREE 6B. Two inorganics were detected at concentrations that exceeded or equaled the WRF site background maximum concentrations in subsurface soil samples collected from MW-60: calcium was detected in the 20 feet bgs sample (1,150 µg/g); the MW-75, 5 to 7 feet bgs sample (700 µg/g); and in the MW-75 duplicate, 5 to 7 feet bgs sample (678 µg/g). The site background maximum concentration for calcium is 454 µg/g. Manganese was detected in the 35 feet sample from MW-60 (1,020 µg/g - the site background maximum concentration for manganese is 617 µg/g). Inorganics detected above background concentrations in shallow soil samples (0 to 2 feet

bgs) collected in OU1 are presented in Figure 7-3. Inorganic compounds detected in subsurface soil samples collected at depths 2 feet bgs or greater are shown in Figure 7-4.

Organics were not detected in soil samples collected from 2 feet bgs to the water table above their respective RBC values, with the exception of benzo (a) pyrene, detected at a concentration of 0.24 µg/g in the 15-17 feet sample collected from MW-75. The WRF site background maximum concentration for benzo(a)pyrene is 0.088 µg/g. Organic compounds detected in subsurface soil samples from depths greater than 2 feet bgs are presented in Table 7-14. Total pesticides and PAHs detected in shallow subsurface soil samples (0 to 2 feet bgs) and subsurface soil samples (> 2 feet bgs) are presented in Figures 7-3 and 7-5, respectively.

### 7.2.11.3 Test Pits

Two test pits were excavated within AREE 6B (TP18 and TP19) to investigate and characterize metal debris found in an area west of Deephole Point Road. A test pit (TP20) was excavated in AREE 6B east of Deephole Point Road to investigate a suspected disposal area where TPH was detected during the 1993 SI (USAEC, 1995c). The locations of the two test pits are illustrated on Figure 7-1. Samples collected from the test pits were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PCTs (if PCBs were detected) and TAL metals. Analytical results for detected compounds are summarized in Table 7-14.

TP18 was trenched in two segments west of Deephole Point road where there was visible debris. Segment 1 was 13 feet long and excavated to a depth of 8.5 feet bgs parallel to the road. No sample was collected from Segment 1. Cable boxes and wire were identified during the excavation of Segment 1. Segment 2 was located north of Segment 1 and trenched perpendicular to Deephole Point Road. Segment 2 was 21 feet long and excavated to a depth of 6.5 feet bgs. Two samples were collected: TP18A at 6.6 feet bgs and TP18B at the surface.

TP19 was trenched south of TP18 where there was visible debris on the surface. TP19 was 34 feet long and excavated to a depth of 9.5 feet bgs. Two samples were collected: TP19A at 8.3 feet bgs and TP19B at the surface. No debris was identified during the excavation of the test pit.

TP20 was trenched east of Deephole Point Road. The test pit was excavated with a southeast/northwest orientation into the hillside. TP20 was 42 feet long and excavated to a depth of 7 feet bgs. Two samples were collected: TP20A at 5 feet bgs and TP20B at the surface. No debris was identified during the excavation of the test pit.

Summary of Results. Several inorganics were detected at concentrations that exceeded the WRF site background maximum concentrations in samples collected at the surface (0-0.5 feet bgs). These compounds include: aluminum in TP20B (16,200, site background concentration of 14,350 µg/g); calcium in TP19B (1,280 µg/g, site background concentration of 1,150 µg/g); copper in TP20B (14.3 µg/g, site background maximum concentration of 12.6 µg/g); magnesium in TP20A (4,240 µg/g, site background maximum concentration 3,700 µg/g), and nickel (site background concentration is 11.9 µg/g from 0 to 2 feet bgs and 17.9 µg/g at depths 2 feet bgs and greater) in TP20A (19.00 µg/g). Two samples, TP20A and TP20B, had potassium concentrations above site background (0 feet - 597 µg/g and 2 feet - 936 µg/g). These samples are TP20A (1,190 µg/g) and TP20B (1,090 µg/g). The sodium concentration in TP20B (650 µg/g) exceeded the WRF site background maximum concentration of 487 µg/g. Vanadium was detected at a concentration of 40.4 µg/g (TP20A), which exceeded the site background maximum concentration of 25.8 µg/g.

Barium slightly exceeded the site background concentration of 73.4 µg/g in TP20A, at a concentration of 74.0 µg/g.

Copper and magnesium exceeded site background concentrations of 12.6 µg/g and 2,610 µg/g, respectively, in sample TP20A (collected at 5 feet bgs). The copper concentration in this sample was 15.0 µg/g and the magnesium concentration was 4,240 µg/g. Inorganics detected in shallow test pit samples (0 to 2 feet bgs) and subsurface soil are presented in Figures 7-1 and 7-4, respectively.

VOCs were not detected above Region III RBCs in test pit samples collected in AREE 6B. PAHs and pesticides detected in test pit samples are presented in Figures 7-3 and 7-5.

#### 7.2.11.4 Groundwater

One well, MW-60, was installed east of AREE 6B to evaluate groundwater quality upgradient of AREE 6B (this well is also, to a lesser degree, located upgradient of AREE 7). One downgradient monitoring well, MW-75, was installed in the extreme western portion of AREE 6B to evaluate groundwater conditions downgradient of AREE 6B. Groundwater samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PCTs (first round sampling) PAHs, TAL metals, and TPH. Analytical results reported for the samples collected from AREE 6B are summarized in Table 7-14.

Summary of Results. Inorganic compounds were not detected in groundwater samples above WRF site background maximum concentrations.

The following organic compounds were detected in the sample collected from MW-60 during the first round of groundwater sampling (Winter, 1995) at low concentrations: 2-methylnaphthalene (2.48 µg/L); DDE (0.024 µg/L), DDT (0.019 µg/L), endosulfan sulfate (0.027 µg/L), Endosulfan II (0.021 µg/L), fluoranthene (0.034 µg/L), gamma-chlordane (0.008 µg/L), and heptachlor epoxide (0.088 µg/L). Of these compounds, none were detected during the Phase I second round of sampling (March, 1996) or in the Phase II round of sampling (Summer, 1996). Total pesticides and PAHs detected in groundwater samples are shown in Figure 7-7.

Organic compounds were not detected in the groundwater sample collected from MW-75 in the first round of groundwater sampling, however DDD was detected at a concentration of 0.006 µg/L in the second round of sampling. No additional organic compounds were detected in groundwater samples collected from this well.

#### 7.2.12 Discussion

Aluminum, beryllium, copper, iron, and selenium were detected at concentrations exceeding WRF site background maximum concentrations in a surface soil sample collected approximately 100 feet east of Deephole Point Road. Some inorganics (calcium and manganese) were detected above background concentrations in soil samples collected from 0 feet to 35 feet bgs from MW-60. Based on soil lithologies described during drilling, MW-60 is located in a stiff clay zone, from ground surface to approximately 18 feet bgs, where a silty sand was encountered. These levels are most likely naturally occurring and not related to past land use or surface water/groundwater chemical transport. Inorganics are also present in levels slightly exceeding background concentrations in test pit samples in this AREE, the most significant metals being aluminum, chromium, copper, nickel, and vanadium. The fact that inorganic compounds were not detected above background concentrations in groundwater samples suggests that most of the metals concentrations detected are naturally-occurring.

Pesticides were detected in groundwater collected from MW-60. Pesticides were not detected during the second round of groundwater sampling and were not detected during Phase II sampling. The tidal effects on groundwater have not been evaluated for this area; therefore, the tidal influences on chemical concentrations cannot be evaluated at this time. Therefore, the source for the PAHs and pesticides remains unknown at this time.

#### 7.2.13 Conclusions

Metals concentrations exceeding WRF site background maximum concentrations are present in surface and subsurface soil in AREE 6B.

Inorganic compounds were not detected above site background maximum concentrations in groundwater samples collected from wells in this area. Lead was present at concentrations slightly below site background levels in surface and subsurface soils.

Organic compounds detected in groundwater include benzo(a)pyrene, benzo(b)fluoranthene, DDT, fluoranthene, and methoxychlor. These compounds are present in low levels in groundwater analyzed from shallow groundwater east of the perimeter of the AREE, but are not present in the extreme western portion of the AREE, based on analytical results from MW-75.

#### 7.2.14 AREE 7 Investigation Results

AREE 7 is a former pistol range located at the intersection of Deephole Point Road and Shady Lane. The range was used for small arms firing on a semi-annual basis during the 1970s.

Sample locations for the surface soil sample and the soil boring/monitoring well (MW-59) drilled to evaluate subsurface soils and groundwater at AREE 7 are presented in Figure 7-1.

##### 7.2.14.1 Surface Soil

One surface soil sample (RISS25) was collected in AREE 7 to evaluate possible surface soil contamination. This sample was collected near the western (downgradient) edge of AREE 7. Analytical results for the samples collected from AREE 7 are presented in Table 7-15.

Summary of Results. Potassium exceeded the site background concentration of 597 µg/g. All remaining inorganic compounds were below WRF site background maximum concentrations. Inorganics detected above background concentrations for OU1 in surface soil samples are shown in Figure 7-1.

Organics were not detected in RISS25 above USEPA Region III residential RBCs.

##### 7.2.14.2 Subsurface Soil

2.0.2.2 Subsurface Soil One soil boring, MW-59 (which was later converted to a monitoring well), was drilled in AREE 7 to evaluate subsurface conditions. The boring log and monitoring well completion diagram is presented in Appendix C. Subsurface soil samples collected from these borings were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, and TPH.

Summary of Results. Inorganic compounds were not detected at concentrations exceeding site background concentrations from shallow soil samples (0 to 2 feet) collected from the MW-59 soil boring.

Two subsurface soil samples were collected from boring MW-59, at depths of 25 feet and 29 feet bgs, respectively. Inorganic compounds were not detected above site background maximum concentrations.

No organic compounds were detected in subsurface soil samples.

##### 7.2.14.3 Groundwater

One monitoring well, MW-59, was installed at AREE 7 to evaluate groundwater quality within this AREE. Groundwater samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PCTs (round 1 sampling event only), PAHs, TAL metals, and TPH.

Summary of Results. Inorganic compounds were detected well below site background maximum concentrations for the groundwater sample collected from MW-59.

No organic compounds were detected in the groundwater sample collected from MW-59.

#### 7.2.15 Discussion

Inorganic compounds in surface, shallow soil samples (0 to 2 feet bgs), and subsurface soil samples were detected at concentrations below site background levels, with the exception of RISS25, in which potassium was detected at a concentration of 1,110 µg/g (exceeding the RBC for potassium in surface soils of 936 µg/g).

Inorganic compounds were detected at levels below background concentrations in groundwater samples and no organic compounds were detected in surface soil, subsurface soils, or groundwater samples.

#### 7.2.16 Conclusions

Inorganic and organic compounds were not present above maximum WRF site background concentrations or RBCs in soil samples (with the exception of potassium) or groundwater samples collected from this AREE.

## 7.3 MAIN COMPOUND INVESTIGATION

OU2, which is comprised of AREEs or the portions of AREEs that are located within the boundary of the Main Compound, contains a total of 23 AREEs. Many of these AREEs were investigated during previous investigations (SI and SSI and UST Site Characterization investigations) and were found to require either no further action or were further investigated under other programs. The following AREEs were investigated further as part of this RI: 8, 11, 12, 14, 17, 20, and 40. The locations of the AREEs are illustrated on Figures 2-4 and 2-5. Media sampled as part of this RI included surface soils, subsurface soils and groundwater. A summary of the samples collected from OU2, including a description of the media and chemical analysis, are presented in Tables 6-8, 6-9, and 6-10. The analytical results for detected compounds for each media sampled are summarized in Tables 7-16 through 7-26. The following sections are a discussion of the results of the RI field investigations at OU2.

### 7.3.1 AREEs Associated with Building 202 Drainage Devices (AREEs 8, 11, 12, and 17)

AREEs 8, 11, 12, and 17 have been presented together in this section because of their proximity to one another. In addition, sampling performed for the RI was designed to investigate this area collectively to evaluate the nature and extent of the potential impacts from runoff and contamination downgradient from these AREEs.

AREE 8 is the site of three former 10,000-gallon steel USTs where diesel fuel and #2 fuel oil were stored from 1966 until they were removed. The fuel tanks were located on the east side of Building 202 (Figure 2-5). One tank was removed in 1981 and replaced with a 2,000-gallon fiberglass UST (which is now AREE 24a). The remaining two tanks were removed in 1990. It should be noted that AREE 24a (2,000-gallon fiberglass UST) previously referred to as an "existing 2,000-gallon UST" was removed in November 1996 and is now referred to as former 2,000-gallon fiberglass UST.

AREE 11 includes the former oil/water separator, which was located to the north of Building 202. This AREE also includes storm lines and drainage devices for the area north of Building 202, but still within the Main Compound (refer to Figure 2-5). The portion of AREE 11 located outside the Main Compound has been designated as part of OU3 and the samples collected in this portion of AREE 11 are presented in the OU3 discussion.

AREE 12 is a former drum storage area located adjacent to the north side of Building 202 where the WRF maintenance facility and vehicle repair facility were located (refer to Figure 2-10). A wide range of organic and inorganic compounds from Building 202 were temporarily placed in drums and stored on the pavement in this area. There are no records of releases, but the paved area contains patches of worn and discolored asphalt. Drainage from this area was toward the former oil/water separator (AREE 11).

AREE 17 is the site of an April 1989 hydraulic oil spill where approximately 100 to 150 gallons of No. 2 hydraulic oil leaked onto the soil. The portion of AREE 17 located outside of the Main Compound boundary is included in OU3. Approximately 40 to 60 tons of contaminated soils were removed after the spill and the soil was incinerated. The spill was located northwest of Building 202 and just west of the antenna tower (refer to Figure 2-5).

#### 7.3.1.1 AREEs Associated with Building 202 Drainage Devices (AREEs 8, 11, 12, and 17)

**Subsurface Soil.** Soil boring, RISB1, was drilled west of the former oil/water separator to evaluate subsurface soils in the area. Soil boring, RISB2, was drilled west of the antenna tower to evaluate the extent of subsurface soil contamination in this area of the compound. MW-61 was drilled downgradient of the Main Compound (at the corner of Bayview and Charlie roads) to evaluate soil and groundwater conditions downgradient of the Main Compound. The locations of the soil borings/monitoring wells are presented in Figure 7-15. Inorganic and organic compounds detected are summarized in Tables 7-16 through 7-19.

Arsenic was detected in RISB2 at a concentration of 2.63 µg/g in 0 to 2 foot sample. The site background concentration for arsenic is non-detect. Calcium was detected in the 0 to 2 foot sample collected from MW-61 (1,010 µg/g) and the 0 to 2 foot sample collected from RISB2 (1,040 µg/g). The site background concentration for calcium is 454 µg/g. Lead was detected



above the site background concentration of 15.0 µg/g in MW-61 (0 to 2 foot sample) at a concentration of 15.0 µg/g. Manganese was also detected in the 0 to 2 foot sample collected from MW-61 at a concentration of 721 µg/g, which is above the site background of 617 µg/g. Potassium was detected above the site background concentration (624 µg/g) in the 0 to 2 foot sample collected from MW-61 at a concentration of 755 µg/g. Selenium was detected at a concentration of 11.6 µg/g in the RISB2 0 to 2 foot sample. The site background concentration for selenium is non-detect. Vanadium was detected in the 0 to 2 foot samples from MW-61 and RISB2 at concentrations of 33.4 µg/g and 35.3 µg/g, respectively. Table 7-16 presents inorganic compounds detected in shallow surface soil samples.

PCB-1260 was detected in RISB1 (0 to 2 foot sample) at a concentration of 0.02 µg/g. TPH, as diesel was detected at concentrations of 49 µg/g and 33.0 µg/g, respectively which are below the VADEQ action level of 100 µg/g, respectively. Table 7-17 presents organic compounds detected in the shallow subsurface soil samples.

The following subsurface soil samples collected from 2 feet bgs to the water table contained analytes/compound concentrations above site background/RBC levels. Arsenic (site background of non-detect) in samples collected from RISB1 (5 to 7 feet bgs - 0.76 µg/g); RISB1 Dup (5 to 7 feet bgs - 1.22 µg/g); and RISB2 (5 to 7 feet bgs - 1.45 µg/g). Calcium (site background concentration of 454 µg/g) was detected at concentrations of 582 µg/g and 561 µg/g, respectively from the 5 to 7 feet bgs samples collected from MW-61 and RISB2. Selenium was detected at concentrations of 15.0 µg/g and 18.4 µg/g in the 5 to 7 feet bgs sample collected from RISB1 and in the RISB1 Dup. Selenium was also detected in the 5 to 7 feet bgs sample collected from RISB2 at a concentration of 14.4 µg/g. The site background concentration selenium is non-detect. Vanadium was detected above the site background concentration of 25.8 µg/g in the 5 to 7 feet bgs sample collected from RISB1 at a concentration of 40.6 µg/g and at a concentration of 50.4 µg/g in RISB1 Dup. The 5 to 7 feet bgs sample collected from RISB2 contained a vanadium concentration of 46.5 µg/g. Table 7-18 presents inorganic analytes detected in subsurface soil samples.

Organic compounds detected in the subsurface soil samples collected from 2 feet bgs to the water table include 2-methylnaphthalene, acetone, naphthalene, phenanthrene, and PCB-1260. The organic compounds detected in the subsurface soil samples above the RBCs are phenanthrene, detected at a concentration of 0.95 µg/g in the 10 feet bgs samples from RISB1, and PCB-1260 (RBC of 0.083 µg/g), detected at a concentration of 0.30 µg/g in the 10 feet bgs samples from RISB1. Table 7-19 presents the organic compounds detected in the subsurface soil samples collected in the Main Compound.

Groundwater. One shallow monitoring well (MW-61) was installed in a downgradient location (at the corner of Bayview and Charlie roads) from suspected source areas associated with the Main Compound to evaluate the extent of subsurface soil and groundwater contamination.

Existing monitoring wells MW-37 and MW-38 installed as part of the Phase II SC, were sampled during this RI (Round I sampling only) to evaluate groundwater quality downgradient of the drum storage area and the former oil/water separator. Existing monitoring wells MW-33, MW-34, and MW-35 were sampled during the RI (Round I sampling only) to evaluate groundwater quality downgradient of the three former 10,000-gallon USTs. Groundwater samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PCTs, PAHs, and TPH with the exception of existing monitoring wells MW-37 and MW-38 which were not analyzed for PCTs. Monitoring well locations are presented in Figure 7-15. Analytical results for these compounds are present in Tables 7-20 and 7-21.

Only two inorganic compounds were detected in above the site background concentrations in the groundwater samples collected in the Main Compound. Magnesium was detected at a concentration of 9,530 µg/L in MW-35 (site background concentration is 7,720 µg/L). Manganese was detected at a concentration of 453 µg/L in MW-33 (site background

concentration is 354 µg/L). Table 7-20 presents the inorganic analytes detected in the groundwater samples collected in the Main Compound,

Chloroform was detected in MW-37 (Round 1) at a concentration of 2.7 µg/L. The RBC for chloroform is 0.15 µg/L. Fluorene was detected in MW-33 and MW-38 at concentrations of 0.801 µg/L and 3.28 µg/L. In addition, naphthalene was detected in MW-33 and MW-38 at concentrations of 3.28 µg/L and 32.4 µg/L, respectively. There is no RBC currently available for naphthalene. Bis(2-ethylexyl)phthalate was detected in MW-39 and MW-39Dup at concentrations of 7.2 µg/L and 10.0 µg/L, respectively. The RBC for bis(2-ethylexyl)phthalate is 4.8 µg/L. All remaining organic compounds were either non-detect or had concentrations below their respective RBCs. Table 7-21 presents organic compounds detected in the groundwater samples collected in the groundwater samples collected in the Main Compound.

### 7.3.2 Discussion

Previous investigations indicate that TPH is present at varying concentrations (143 µg/g to 2,166 µg/g) above the VADEQ action level of 100 µg/g in soil borings and test pit soil samples collected on the eastern side of Building 202 where the three former 10,000-gallon USTs were located. Low levels of acenaphthene and 2-methyl naphthalene were detected in the groundwater sample collected from MW-33 at concentrations. These levels are below residential RBCs.

Soil samples collected during the excavation of the oil/water separator contained TPH at concentrations from 145 µg/g to 4,937 µg/g. These are greater than the VADEQ action level for TPH of 100 µg/g. A sediment sample collected from the oil/water separator outfall contained 1,200 µg/g PCB-1260. Confirmation samples were collected during the removal of the oil/water separator and drainage ditch excavation showed PCB concentrations as high as 210 µg/g in a sample collected from the sidewall of the excavation. The former oil/water separator and washrack are likely the source of the PCB concentrations detected. However, it should be noted that the oil/water separator, washrack, and contaminated soil associated with these structures as well as soils from the drainage ditch (approximately 1100 yards) were removed in 1995. This area was further investigated during this RI to determine if the excavation and removal of the oil/water separator was complete and/or if it had impacted soils and groundwater in the area. Of the three borings (RISB1 and RISB2 and MW-61) advanced in the area, one soil boring had concentrations of PCBs greater than the residential RBC in the soil samples collected from 5 to 7 feet bgs and from 10 to 12 feet bgs with a maximum detected concentration of 0.30 µg/g. Soil boring RISB1 advanced next to the former oil/water separator, also contained detectable concentrations of TPH and four other organic compounds including PCBs which were below their respective RBCs. No other significant organics or inorganics were detected in the soil borings.

Fluorene and naphthalene were detected at low concentrations, however the RBCs for these compounds are not currently available. Chloroform was detected above the RBC in the groundwater sample collected from MW-37. However, chloroform is a common laboratory contaminant. It is likely that this compound is not related to the drum storage area. No other significant organic or inorganic compounds were detected in the groundwater from wells near the drum storage area.

### 7.3.3 Conclusions

PCB-1260 contamination is present in subsurface soils near the former oil/water separator, as shown by sample RISB1. The groundwater in the area has not been impacted.

Soils and groundwater northeast of Building 202 have not been impacted by activities from AREE 12 (the drum storage area). No further action is recommended for AREE 12.

Surface and subsurface soils near the hydraulic oil spill area were impacted by the spill. Organic constituents typical of hydraulic oil were detected in surface and subsurface soil samples collected in the area. However, the concentrations are low and no risk associated with these compounds is anticipated. The groundwater does not appear to have been impacted by the spill. The pesticide dieldrin detected above its RBC is probably due to past use at the facility.

### 7.3.4 AREE 14 - Former Oil/Water Separator

AREE 14 is the former oil/water separator located adjacent to the north side of Building 211 (Figure 2-5). The separator received drainage from the work area inside Building 211 and discharged to the grassy area east of the Main Compound. There have been no spills reported from the work areas inside Building 211 and no significant amounts of hazardous liquids are believed to have been stored or handled in this area (USAEC, 1996).

### 7.3.5 Results of Remedial Investigation

Groundwater. Existing monitoring well MW-41 was sampled during the RI to evaluate current groundwater quality downgradient of AREE 14. The sample was analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PAHs, TAL metals, and TPH. No organic compounds were detected and no inorganic compounds were detected above site background values in the groundwater sample. A summary of the analytical results from the samples collected in AREE 14 is given in Table 7-22.

### 7.3.6 Conclusions

Based on the above reported results there appears to be no significant contamination from past site activities. No further action is recommended for AREE 14.

### 7.3.7 AREE 20 - Former Incinerator

AREE 20 has been designated as the former incinerator which was located in the Main Facility Compound. The location is presented on Figure 2-5. The incinerator was used from the 1950's until 1970. Ash was periodically removed from the stack, drummed, and disposed of in one of the on-site landfills. The incinerator was dismantled in 1972 and disposed of in Former Dump No. 1, AREE 1, (USAEC, 1996).

### 7.3.8 AREE 20 Remedial Investigation Results

Surface Soil. The reporting limits associated with the analytical method for dioxins used during the Phase II SI were greater than the RBCs. Therefore, dioxins might have been present at concentrations exceeding their RBCs. To determine if dioxins were present at concentrations greater than their RBCs, four surface soil samples were collected during Phase II of the RI from the locations previously sampled and were analyzed for dioxins using USEPA SW-846 Method 8290. This method achieves reporting limits for dioxins below their RBCs. Samples locations are the same as those collected during Phase II of the SI and are presented in Figure 6-3. Background surface soil samples RISSBK-3 through RISSBK-5 were also analyzed for dioxins as a comparison (refer to Figure 6-1). The analytical results of these samples are summarized in Table 7-23.

Octachlorodibenzo-p-dioxin (OCDD) was the only dioxin to be detected above RBC (0.004 µg/g). OCDD was detected in 20SS0101, 20SS0201, and 20SS0301 at 0.0043 µg/g, 0.0046 µg/g, and 0.0053 µg/g, respectively. However, OCDD was also detected in all three background surface soil samples with the highest concentration detected in RISSBK-4 at 0.0074 µg/g.

### 7.3.9 Discussion

Dioxins were detected in three of the four surface soil samples at concentrations slightly greater than RBCs, but since they were also detected in background samples at higher concentrations, the results are likely not site specific. It should be noted that WRF is located in a highly urbanized and the dioxins detected may be due to off-site sources.

### 7.3.10 Conclusions

No further action is recommended for AREE 20.

### 7.3.11 AREE 40 - Former Water Tower

AREE 40 was established by the BCT in February 1995 based on concerns that lead contamination from paint stripping activities has been associated with water towers at other facilities

(USAEC, 1996b). Surface soil samples were collected in AREE 40 and a summary of the analytical results is given in Table 7-24.

### 7.3.12 AREE 40 Remedial Investigation Results

**Surface Soil.** Four follow-up surface soil samples (RISS60 through RISS63) were collected on each side of the former water tower site during the Phase II RI to evaluate the nature and extent of lead contamination. The soil samples were analyzed for TAL metals. Beryllium was detected above the site background concentration (0.814 µg/g) at 0.864 µg/g in sample RISS61. Manganese was also detected, above the WRF site background concentration of 875 µg/g, in surface soil sample RISS61 at a concentration of 1,200 µg/g. Lead was detected at 111 µg/g, 133 µg/g, 176 µg/g, and 113 µg/g in surface soil samples RISS60 through RISS63, respectively. All of these concentrations are above the WRF site background concentration for lead of 22.4 µg/g but below the RBC for lead of 400 µg/g. Sampling locations are presented on Figure 6-3.

### 7.3.13 Conclusions

Because the concentrations of lead detected in all four surface soil samples is significantly lower than the RBC, no further action is recommended.

## 7.4 OPERABLE UNIT THREE INVESTIGATIONS

OU3 includes AREE 22 (the Main Drainage Ditch), the portion of AREE 11 that is located north and outside of the Main Compound, and also the portion of AREE 17 that is located north and outside the Main Compound. The boundaries of OU3 are illustrated on Figure 2-4. The primary focus of the RI relating to OU3 was the collection of sediment and surface water samples from the Main Ditch, north of Charlie Road and the collection of fish tissue samples from parts of this ditch. The area of the ditch directly north of the Main Compound received runoff from the former oil/water separator and the former washrack, and PCBs are the primary chemical of concern. The upper-most reaches of the drainage ditch have received runoff from on-site and off-site sources. In addition, the small area outside the Main Compound and directly east and west of the PCB excavation trench (the portions of AREEs 11 and 17 discussed above) was investigated through subsurface soil sampling of five soil borings (converted to monitoring wells MW-55, MW-56, MW-57, MW-58, and MW-85), three additional soil borings (RISB3, RISB4, and RISB5), three surface soil samples (RISS51, RISS52, and RISS53), and seven groundwater samples (five of which were collected from monitoring wells MW-55 through MW-58, MW-85, and two deep wells installed during the RI, MW-62 and MW-84). The results of previous investigations for AREEs within OU3 are presented in Section 5.0 and summary tables of sample identifications and specific analyses performed for each sample are presented in Tables 6-11 and 6-12. Sample locations for the soil borings, surface soil samples and monitoring wells are illustrated on Figure 7-15. Surface water and sediment samples are presented in Figure 6-5. Analytical results for the samples collected in OU3 for this RI are summarized in Table 7-26, 7-27 and 7-28.

### 7.4.1 AREEs 11 and 17 (Portions outside the Main Compound)

#### 7.4.1.1 Surface Soil

Three surface soil samples (RISS51 through RISS53) were collected in the grassy area between the Main Compound and the Main Drainage Ditch to determine if runoff from the former oil/water separator had impacted surface soil. One sample was collected from the eastern side of the PCB excavation ditch and two from the western side of the PCB excavation ditch. Surface soil samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH. Analytical results of these samples are summarized in Tables 7-25.

Two inorganic compounds were detected at concentrations exceeding site background. Barium was detected in both RISS51 and RISS52 at concentrations of 98.0 µg/g and 95.4 µg/g, respectively. The site background concentration for barium is 92.4 µg/g. Zinc was detected in the same samples at concentrations of 49.2 µg/g and 49.4 µg/g, respectively. The site background concentration for zinc is 43.9 µg/g. PCB-1260 was detected in RISS52 and RISS53 above the RBC of 0.083 µg/g at concentrations of 0.123 µg/g and 0.149 µg/g, respectively.

#### 7.4.1.2 Subsurface Soil

Three soil borings (RISB3 through RISB5) were drilled to evaluate the extent of contamination in the area near the PCB removal action. One soil boring, RISB3, was drilled adjacent to the head wall of the drainage ditch along Locust Road, where the culvert crosses under the road. Soil boring RISB4 was drilled adjacent to the sidewall of the PCB excavation ditch, to further evaluate the area where the 210 µg/g of PCB-1260 was detected. Soil boring RISB5 was drilled between the PCB excavation ditch and monitoring wells MW-56 and MW-62 to evaluate potential subsurface soil contamination within this area. In addition, subsurface soil samples were collected during the installation of monitoring wells MW-55, MW-56, MW-57, MW-58, MW-84 and MW-85. Analytical results of these samples are summarized in Table 7-25. Two deep monitoring wells, MW-62 and MW-84 were drilled using the mud-rotary drilling process and therefore were not sampled.

Arsenic was detected at a concentration of 1.55 µg/g in the shallow subsurface (0 to 2 feet bgs) soil sample collected from MW-56. The WRF site background concentration for arsenic is non-detect. Barium was detected in two samples, MW-56 and MW-57, (0 to 2 feet bgs) at respective concentrations of 89.6 µg/g and 86.6 µg/g. The site background concentration for barium is 73.8 µg/g. Calcium was detected in several shallow subsurface soil samples above the RBC of 454 µg/g. The shallow subsurface soil sample collected from MW-85 had a concentration of copper of 28.6 µg/g. The site background concentration for copper is 16.9 µg/g. The following 0 to 2 feet bgs soil samples had concentrations of lead exceeding the site background concentration of 11.8 µg/g: MW-55 (26.8 µg/g); MW-57 (20.3 µg/g); MW-85 (25.3 µg/g); and RISB3 (26.7 µg/g). The 0 to 2 feet bgs sample collected from the MW-58 boring had a manganese concentration of 788 µg/g. All other shallow subsurface soil sample manganese concentrations from this area were below the site background concentration of 617 µg/g. Selenium had a concentration of 11.6 µg/g in the shallow subsurface soil sample collected from RISB2. The site background concentration for selenium is non-detect. Several soil samples (0 to 2 feet bgs) had concentrations of vanadium exceeding the site background concentration of 25.8 µg/g. These samples include: MW-55 (34.0 µg/g); MW-57 (30.7 µg/g); MW-85 (33.1 µg/g); RISB3 (37.6 µg/g); RISB4 (35.1 µg/g) and RISB5 (26.1 µg/g).

The only organic compound detected above its RBC in shallow subsurface (0 to 2 feet bgs) was PCB-1260. This compound was detected in several soil samples. These include: MW-55 (0.29 µg/g); MW-57 (0.39 µg/g); MW-85 (0.339 µg/g); RISB3 (0.70 µg/g); RISB4 (0.48 µg/g); and RISB5 (0.12 µg/g). The RBC for PCB-1260 is 0.083 µg/g (this value is for carcinogenic RBCs).

Aluminum was detected in the 15 to 17 feet bgs sample collected from the MW-56 soil boring at a concentration of 18,500 µg/g. The maximum site background concentration for aluminum is 18,200 µg/g. Arsenic was detected in the 15 to 17 feet bgs sample from MW-56 at a concentration of 0.95 µg/g. The site background concentration for arsenic is non-detect. Four soil samples had concentrations of barium above the maximum site background concentration of 73.8 µg/g. These samples are as follows: MW-55 (12-14 feet bgs - 112 µg/g) and MW-55 (15 to 17 feet bgs - 88.6 µg/g); MW-56 (15 to 17 feet bgs - 79.7 µg/g); and MW-57 (5-7 feet bgs - 77.3 µg/g). Beryllium was detected in both the 12-14 feet bgs and 15 to 17 feet bgs samples collected from the MW-55 soil boring at respective concentrations of 1.20 µg/g and 1.29 µg/g. The site background concentration for beryllium is 1.02 µg/g. Calcium was detected at concentrations exceeding the site background concentration of 454 µg/g in soil samples collected from the following borings: MW-55 (12-14 feet bgs and 15 to 17 feet bgs) and MW-56 (10-12 feet bgs and 15 to 17 feet bgs). Chromium was detected above the site background concentration of 25.0 µg/g in MW-55 (15 to 17 feet bgs) at a concentration of 30.3 µg/g and in MW-56 (15 to 17 feet bgs) at a concentration of 26.6 µg/g. Cobalt was detected at a concentration of 27.8 µg/g in the 15 to 17 feet bgs sample collected from MW-55. The WRF site background maximum concentration for cobalt is 13.9 µg/g. MW-55 soil samples contained concentrations of copper (12-14 feet bgs - 23.1 µg/g and 15 to 17 feet bgs - 32.1 µg/g) that exceeded the site background concentration of 32.1 µg/g. Lead concentrations exceeded the WRF site background maximum concentration of 11.8 µg/g in samples collected from MW-55 (12-14 feet bgs) and MW-56 (15 to 17 feet bgs) at respective concentrations of 11.9 µg/g and 13.6 µg/g. The site background concentration for lead is 11.8 µg/g. Magnesium exceeded the WRF site background maximum concentration of 3,700 µg/g in MW-55 (15 to 17 feet bgs) at a concentration of 3,950 µg/g.

Nickel (site background concentration of 17.9 µg/g) was detected in the 12-14 feet bgs and 15 to 17 feet bgs soil samples collected from MW-55 at concentrations of 20.3 µg/g and 36.0 µg/g, respectively. Potassium was detected in MW-55 and MW-56 at concentrations greater than the site background concentration of 624 µg/g. Selenium was detected at concentrations of 16.3 µg/g and 13.7 µg/g, respectively in soil samples collected from RISB3 and RISB5. The WRF site background concentration for selenium is non-detect. Vanadium was detected in samples from MW-55, MW-56, MW-57, and RISB3 at concentrations exceeding the site background concentration of 25.8 µg/g.

#### 7.4.1.3 Groundwater

Five shallow monitoring wells, (MW-55 through MW-58 and MW-85) and two deep monitoring wells (MW-62 and MW-84) were installed in downgradient locations from suspected source areas associated with Building 202 to evaluate the extent of subsurface soil and groundwater contamination. MW-55 was installed in an area where stressed vegetation has been observed. This area received surface water runoff from the former oil/water separator and is also where the hydraulic spill occurred. A sand lens was encountered during the PCB removal action. The lens is believed to trend northwest from the former oil/water separator. Therefore, shallow monitoring well/soil boring MW-56 and deep monitoring well MW-62 were installed downgradient of the former oil/water separator, located to intercept the sand lens, if possible, to determine if the groundwater has been affected by contamination which may have migrated from the former oil/water separator through the sand lens. Groundwater samples collected from MW-56 and MW-62 were analyzed to evaluate whether upper and lower groundwater zones are contaminated due to migration of TPH and PCBs detected in this area. Soil boring/monitoring well MW-57 was located adjacent to the drainage ditch to evaluate groundwater quality prior to potential discharge to the Main Drainage Ditch. Soil borings/monitoring wells MW-58 and MW-85 were installed downgradient of the PCB excavation in order to determine if the soils and/or groundwater downgradient have been impacted by the contamination found during the excavation.

Existing monitoring well, MW39, was installed as part of the Phase II SC, and was sampled during this RI (Round 1 sampling only) to evaluate groundwater quality downgradient of the drum storage area. Groundwater samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PCTs (Round 1 only), PAHs, and TPH. Analytical results of these samples are summarized in Table 7-26.

Iron was detected above the WRF site background maximum concentration (9,620 µg/L) in six monitoring wells: MW-56 (17,200 µg/L); MW-57 (14,600 µg/L); MW-62 (18,000 µg/L); MW-56 Round 2 (15,800 µg/L); MW-57 Round 2 (15,000 µg/L); and MW-62 (15,300 µg/L). Manganese was detected above the WRF site background maximum concentration of 354 µg/L in the following monitoring wells: MW-56 (399 µg/L); MW-57 (411 µg/L); MW-62 (562 µg/L); MW-85 (471 µg/L); MW-85 Dup (493 µg/L); MW-56 Round 2 (370 µg/L); MW-57 Round 2 (434 µg/L); and MW-62 Round 2 (494 µg/L). Zinc was detected in the following samples collected from monitoring wells within the Main Compound: MW-39 (205 µg/L); MW-39 Dup (226 µg/L); MW-55 (182 µg/L); MW-85 (94.5 µg/L) and MW-55 Round 2 (119 µg/L). The site background for zinc is 46 µg/L.

Dieldrin was detected in MW-55 at a concentration of 0.009 µg/L. The RBC for dieldrin is 0.0042 µg/L. Phenanthrene was detected in MW-84 Round 2 at a concentration of 0.715 µg/L.

#### 7.4.2 Summary of Results

Surface soil samples contained concentrations of barium and zinc above WRF site background concentrations. PCB-1260 was detected above the RBC of 0.083 µg/g in RISS52 and RISS53.

Shallow subsurface soil samples contained several metals above site background concentrations. Arsenic was detected in the 0 to 2 feet bgs sample collected from MW-56 at a concentration of 1.55 µg/g. Barium, calcium, copper, lead, manganese selenium, and vanadium were detected at levels exceeding their respective maximum site background concentrations. PCB-1260 was detected in shallow subsurface soil samples from MW-55, MW-57, MW-85, RISB3, RISB4, and RISB5 at concentrations above the PCB-1260.

Deeper subsurface soil samples contained the following metals at concentrations exceeding their respective site background concentrations: aluminum; arsenic; beryllium; calcium; chromium; cobalt; lead; magnesium; nickel; potassium; selenium; and vanadium.

Groundwater samples collected from this area contained metals concentrations exceeding site background in iron, manganese, and zinc. Dieldrin and phenanthrene were detected in MW-55 and MW-85, respectively at relatively low concentrations.

#### 7.4.3 Surface Water/Sediment Sampling, 1995

Surface water and sediment samples were collected as part of this RI. A total of 45 samples were collected throughout the WRF, and 16 samples (RISW/RISD24, and RISW/RISD26 through RISW/RISD40) were collected from OU3 at locations illustrated on Figure 7-17. Three additional sediment samples were collected from sample location RISD32 to evaluate the vertical extent of PCB contamination at that location. The following samples were collected RISD32a at 0.5 to 1 feet bgs; RISD32b at 1.5 to 2.0 feet bgs; and, RISD32c at 2.5 to 3.0 feet bgs. The surface water/sediment samples were analyzed for TCL VOCs, TCL SVOCs, PAHs, pesticides/PCBs, PCTs, TPH, TAL metals, grain size distribution, and total organic carbon. The vertical profile samples (RISD32a, b, and c) were analyzed for PCBs. A summary of detected compounds is given in Tables 7-27 and 7-28.

The grain size distribution for the sediment samples collected in the study area (RISD26 through RISD35) consisted predominantly of silt and clay. The percent silt ranged from 42% to 56% (with the exception of samples RISD29 and RISD31) and the percent clay ranged from 14% to 33%.

##### 7.4.3.1 Summary of Results

PCBs, pesticides, PAHs, TPH, and elevated levels of metals were detected in samples collected from this area. Total concentrations for inorganic compounds and pesticides in surface water are shown on Figure 7-17. Total concentrations for PCBs, TPH, pesticides, and PAHs, and inorganic compounds are illustrated on Figures 7-18 through 7-19, respectively.

PCB-1260 was detected at concentrations ranging from 6.04 µg/g at location RISD32 to 0.043 µg/g at location RISD35. As noted above, sample RISD32 (collected at 0 feet bgs) contained 6.04 µg/g of PCB-1260. Whereas samples RISD32a, RISD32b, and RISD32c collected at 0.5 feet bgs, 1.5 feet bgs, and 2.5 feet bgs, respectively, contained concentrations of 0.072 µg/g, 0.161 µg/g, and 0.031 µg/g, PCB-1260. The area where PCB was detected is topographically downgradient from the former oil/water separator and the former washrack. The results of the vertical profile indicate that PCB concentrations are diminishing with depth.

Several PAHs were detected including 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, benzoic acid, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene. The WRF is located in a highly urbanized area and the PAHs are attributed to its regional location.

The pesticides, chlordane (total), alpha-chlordane, gamma-chlordane, and DDD were detected at four of the ten locations sampled. Chlordane (total) was detected in samples RISD28 and RISD29, at 0.263 µg/g and 0.041 µg/g, respectively. Of the 0.263 µg/g total chlordane detected in RISD28, 0.021 µg/g was alpha-chlordane and 0.03 µg/g was gamma-chlordane. Alpha-chlordane and gamma-chlordane were also detected at sample location RISD27 at concentrations of 0.016 µg/g and 0.022 µg/g, respectively. DDD was detected at sample location RISD27 and RISD35 at concentrations of 0.016 µg/g and 0.024 µg/g, respectively. It is assumed that their presence is due to past pesticide use and possibly migration from off-site sources. However, it is not completely understood why the pesticides would occur specifically at these locations and not at other locations in the ditch.

TPH (as diesel) was detected at low levels (below the VADEQ Action Level of 100 µg/g) at three sample locations, RISD26, RISD33, and RISD34. Sample location RISD26 is located topographically downgradient from the former UST at Building 101, the most likely source area for the TPH detected at this location. The source for the TPH detected at sample locations RISD33 and RISD34 is most likely the former USTs and possibly the former oil/water separator located within the Main Compound.

Elevated levels of the following inorganic compounds were detected in surface water samples collected from the upper reaches of the drainage ditch: aluminum, arsenic, barium, copper, iron, lead, vanadium, and zinc. The elevated levels were detected in the northern portion of OU3. The samples were collected during a storm event and it is believed that the elevated levels of metals are a result of runoff from the area north of the facility where construction activities for the golf course were underway at the time of sample collection. The construction activities disturbed vegetation in the area and exposed soils. During the storm event, runoff came in contact with the exposed soils which are a source of naturally occurring metals. This is especially relevant because the surface water samples were unfiltered and sediments from the runoff likely increased the concentrations of metals detected in the surface water samples. Pesticides and inorganics detected above background concentrations in surface water are presented on Figure 7-17.

#### 7.4.4 Summary of Investigations

The past investigations (including the Virginia Bioaccumulation Initiative and the SI) indicate that sediments in the lower portion of OU3, north of the Main Compound, are contaminated with PCB-1260. The highest concentration of PCB-1260 were detected in samples collected for the Virginia Bioaccumulation Initiative and the SI. These samples were collected very close to the drainage swale and outfall area for the former oil/water separator and former washrack. The highest concentrations occur closest to the drainage swale/outfall downgradient from the former washrack and oil/water separator. PCB-1260 concentrations decrease with distance from this area and have not been detected downstream from sample location R1SD36. PCBs have not been detected upstream from sample location R1SD30 which is located upstream from the drainage swale/outfall area north of the Main Compound. Therefore, the source of the contamination has been identified as the former oil/water separator and the former washrack where PCB contaminated oils were disposed.

Pesticides are localized (with the exception of sample location R1SD35) to the northern branches of Main Drainage Ditch (AREE 22) near sediment sample locations R1SD27 and R1SD28. The source of the pesticides is assumed to be due to past use or disposal and possibly migration from off-site sources.

Several PAHs have been detected in sediments throughout OU3 as well as the rest of the site. The WRF is located in a highly urbanized area and the presence of PAHs in sediment may be due to its location in the urbanized setting. Other sources may be a result of runoff from areas where these compounds accumulated during past operational and disposal activities associated with the site.

Elevated levels of aluminum, arsenic, barium, copper, iron, lead, vanadium, and zinc were detected in surface water samples collected from the northern branches of OU3. These samples were collected during storm events and the elevated levels have been attributed to suspended soils and sediment from runoff which affected the sample results.

Arsenic, beryllium, chromium, cobalt, copper, lead, selenium and vanadium were detected in subsurface soil samples above site background concentrations. Most of the elevated metal concentrations were present in samples collected from MW-55 and MW-56, located just north of the Main Compound and west of the PCB excavation trench. Subsurface soil samples from remaining boring within this area displayed metals concentrations below site background.

### 7.5 OU4 INVESTIGATIONS

OU4 contains the remaining 16 AREEs, all of which are located throughout the WRF. These AREEs are as follows: AREE 9, 23a, 24e, 24f, 25, 26, 29, 30, 33 through 39, and 41. Most of these AREEs were found as a result of previous investigations, to require no further action and therefore will not be discussed in this RI. Specific information regarding these AREEs can be found in the Draft Final FFS for OU2 and OU4 (USAEC, 1997). AREEs requiring additional investigation as a part of this RI include 23a, 39, and 41. These AREEs are discussed in the following sections.

#### 7.5.1 AREE 23a - Former UST (Building 101)

AREE 23a, the site of a former 1,000-gallon steel UST used for #2 fuel oil storage, is located adjacent to Building 101 (refer to Figure 2-4). The tank was installed in 1966, and was removed in 1991



when it failed a leak test. It was replaced with an above ground storage tank. Analytical results are summarized in Table 7-29.

### 7.5.2 Results of Remedial Investigation

One soil boring (RISB7) was drilled in the paved area adjacent to the boring in which TPH was detected during the UST investigation. Subsurface soil samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, and TPH. Calcium was detected in all subsurface soil samples above site background (454  $\mu\text{g/g}$ ) with a maximum detected concentration of 871  $\mu\text{g/g}$ . Iron was detected in one sample (15 feet bgs) above the site background value (27,800  $\mu\text{g/g}$ ) at a concentration of 50,200  $\mu\text{g/g}$ . No other inorganics were detected above site background values. Potassium was detected above site background concentrations (624  $\mu\text{g/g}$ ) in sample RISB7 (15 feet bgs) at a concentration of 643  $\mu\text{g/g}$ . Vanadium was detected above site background concentration (25.8  $\mu\text{g/g}$ ) in one sample (15 feet bgs) at a concentration of 47.5  $\mu\text{g/g}$ . No organics were detected in the subsurface soil samples collected from RISB7. The sample location and inorganic results detected above site background values are presented in Figure 7-20. Analytical results for compounds detected are for soil samples collected in AREE 23a are presented in Table 7-26.

### 7.5.3 Discussion

Samples collected during the previous investigations indicated that the soils contained levels of TPH significantly above the VADEQ action level. However, samples collected during the RI investigation did not confirm this.

### 7.5.4 Conclusions

Because the UST has been removed and no TPH or other compounds were detected above site background values, with the exception of iron, calcium, potassium, and vanadium, no further action is recommended.

### 7.5.5 AREE 39 - Debris Piles

During a facility site walk conducted by the BCT in January 1995, debris piles consisting of metallic debris, construction material, and unidentified piles of soil were identified south of the Hunter Qualification Range. This area was designated as AREE 39 by the BCT in February 1995 (refer to Figure 2-4).

### 7.5.6 Results of Phase II Remedial Investigation

Surface Soil. Three additional debris piles were identified which required characterization. Three surface soil samples (RISS57 through RISS59) were collected to evaluate the extent of contamination associated with the debris piles. The samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, PAHs, TAL metals, and TPH. If PCBs were detected the samples were analyze for PCTs. The analytical results for compounds detected are summarized in Table 7-30.

Inorganic compounds were not detected above their site background levels, with the exception of copper and zinc. Copper was detected at concentrations of 44.2  $\mu\text{g/g}$  and 51.4  $\mu\text{g/g}$  in samples from RISS59 and RIS59Dup, respectively. The site background concentration for copper is 12.6  $\mu\text{g/g}$ . Zinc was detected in RISS59 and RISS59Dup at concentrations of 47.2  $\mu\text{g/g}$  and 45.5  $\mu\text{g/g}$ , respectively. The site background concentration for zinc is 43.9  $\mu\text{g/g}$ . No organics were detected at concentrations above the RBC. Sample locations and inorganic analytes detected above background concentrations are presented in Figure 7-16.

### 7.5.7 Conclusion

Because no chemicals of potential concern were identified in the debris piles, no further action is recommended.

### 7.5.8 AREE 41 (Old Homestead) Investigations

AREE 41 is the Old Homestead site and was designated as an AREE when groundwater samples collected from background well MW-63 were found to contain a number of organic compounds. Two additional wells/soil borings (MW-86 and MW-87) were installed to evaluate the detected concentrations of organic compounds. Groundwater samples were also collected from piezometers PZ-4, PZ-5 and PZ-6 during Phase II of the RI. A summary of the analytical results is included as Table 7-31.

1-Methylnaphthalene and bis(2-ethylhexyl)phthalate were detected once each above RBCs (110 µg/L and 4.8 µg/L) at 119 µg/L and 7.7 µg/L in MW-63. They were not detected above their RBCs in the duplicate sample. Dieldrin was detected in MW-63 and the duplicate above the RBC (0.0042 µg/L) at 0.026 µg/L and 0.018 µg/L, respectively. Chloroform was detected in MW-86 and the duplicate above its RBC (0.15 µg/L) at 3.47 µg/L and 3.57 µg/L, respectively. In addition, diesel range and gasoline range organics were detected at maximum concentrations of 1140 µg/L and 740 µg/L, respectively from monitoring well, MW-63. BTEX compounds were also detected and ranged from 13 µg/L ethylbenzene to 54 µg/L xylenes. Three organic compounds (methylene chloride, acetone, and bis(2-ethylhexyl)phthalate) were detected in subsurface soil samples. All of these were less than their respective RBC. Sample locations are presented in Figures 7-20, 7-21, 7-22, and 7-23.

### 7.5.9 Conclusions

The three organic compounds only slightly exceeded RBCs. Further investigations of this AREE are planned for this AREE.

## 7.6 OPERABLE UNIT FOUR/SITE WIDE (RESULTS OF THE REMEDIAL INVESTIGATION)

### 7.6.1 Surface Soil

Twenty-six surface soil samples (RISS26 through RISS50, RISS64, RISS65, and RISS66) were collected throughout OU4 to evaluate site-wide environmental conditions and use for the site-wide risk assessments. Samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, and, PAH. If PCBs were detected, the sample was analyzed for PCTs as well. A sample summary is presented in Table 6-16. The site wide locations are shown on Figure 6-3. Inorganic and organic analytes detected in the surface soil samples collected throughout the site are presented in Tables 7-32 and 7-33, respectively.

Aluminum was detected in two surface soil samples above the site background concentration of 14,350 µg/g, with a maximum detected concentration of 25,400 µg/g in RISS26. Chromium was detected once above the site background (31.3 µg/g) in RISS26 at 39.2 µg/g. Beryllium was detected above its site background value (0.814 µg/g) in ten surface soil samples in concentrations ranging from 0.836 µg/g (detected in sample RISS46) to 1.31 µg/g (detected in sample RISS30). Iron was detected in two surface soil samples above its site background concentration (28,100 µg/g) at 31,400 µg/g (RISS26) and 35,000 µg/g (RISS27). Manganese was detected in eight surface soil samples above the site background (875 µg/g) in concentrations ranging from 953 µg/g (detected in sample RISS30) to 1,750 µg/g (detected in sample RISS49). Vanadium was detected in RISS27 above the site background (58.9 µg/g) at 73.2 µg/g.

PCB-1254 was the only organic compound to be detected above the RBC (0.16 µg/g). The sample from RISS44, located south of the Main Compound Facility and east of Fox Road contained 0.228 µg/g of PCB-1254. RISS44 is also located within a section of an AREE 35 antenna field. The inorganic compounds detected above site background are presented in Figure 7-16.

### 7.6.2 Subsurface Soil

Subsurface soil samples were collected during the installation of 11 piezometers (PZ-3 through PZ-13) throughout OU4. Inorganic and organic analytes detected in the shallow subsurface (0-2 feet bgs) soil samples are presented in Tables 7-34 and 7-35, respectively. Inorganic and organic analytes detected in the deep subsurface (2 feet to the water table) soil samples are presented in Tables 7-36 and 7-37.

Only one sample collected from 0 to 2 feet bgs had beryllium detected above the site background value (1.02 µg/g). Beryllium was detected at a concentration 1.13 µg/g in PZ-13. All but one subsurface soil sample collected from 0 to 2 feet bgs contained calcium at concentrations greater than site background (454 µg/g). The highest concentration detected was 1,310 µg/g from PZ-10. Manganese was detected in three subsurface soil samples from 0 to 2 feet bgs above the site background (617 µg/g) with a maximum detected concentration of 1,320 detected in PZ-8. Potassium was detected in two subsurface soil samples from 0 to 2 feet bgs above the site background (624 µg/g). Vanadium was detected in all but one sample collected from 0 to 2 feet bgs above the site background (25.8 µg/g) at a maximum concentration of 62.3 µg/g, collected from PZ-8 Dup. Organic compounds were not detected above the RBCs from 0 to 2 feet bgs in subsurface soil samples collected from the piezometers. Figure 7-16 presents the analytes detected above background concentrations in the shallow soil samples.

Aluminum was detected in PZ-7 at 5 feet bgs above the site background (18,200 µg/g) at 21,900 µg/g. Calcium was detected above the site background (454 µg/g) in eight subsurface soil samples collected from 2 feet bgs to the water table. Chromium was detected above the site background value of 25.0 µg/g at a maximum concentration of 39.4 µg/g in PZ-9 at 10 feet bgs. Iron was detected in one subsurface soil sample from PZ-9 at 10 feet bgs above its site background value (27,800 µg/g) at a concentration of 42,100 µg/g. Magnesium was detected in one subsurface soil sample slightly above the background concentration of 3,700 µg/g. Manganese was detected in three subsurface soil samples from piezometers PZ-8 and PZ-10 above its site background value (617 µg/g) with a maximum detected concentration of 1,520 µg/g from PZ-8 at 10 feet bgs. Potassium was also detected in four subsurface soil samples above the site background concentration of 624 µg/g. Vanadium was detected in most subsurface soil samples collected from 2 feet bgs to the water table above the site background (25.8 µg/g). The maximum concentration (103 µg/g) was detected in PZ-9 at 10 feet bgs. Benzo(a)pyrene was the only organic detected above its RBC (0.088 µg/g) at 0.31 µg/g in PZ-9 at 10 feet bgs. Sample locations along with concentrations of inorganic and organic analytes detected above background are presented in Figures 7-20 and 7-21.

### 7.6.3 Surface Water/Sediment

Surface water and sediment samples were collected at locations selected to evaluate potential impacts from past operations at WRF and use for the site-wide risk assessment. WRF drainage patterns were considered in choosing the sampling locations. Primarily, sample locations were selected in areas thought to be representative of the entire area, while also focusing on locations of special interest, such as areas where live clam boxes were deployed. A total of 50 locations including 5 background locations were selected to be sampled for surface water during the Phase I investigation. Two additional sediment samples were collected during Phase II near sample location RISD2 to evaluate a PCB hit that was detected during the Phase I investigation. The sample locations are labeled RISW1 through RISW45 and RISD1 through RISD45. Sample locations RISW7 through RISW21 (also including the sediment samples) are associated with OU1 and are not included in this discussion. Sample locations RISW-26 through RISW35 (including sediment sample locations) are associated with OU3 and are not included in this discussion. Sample locations RIBKSW1 through RIBKSW5 and RISDBK1 through RISDBK5 are the background locations collected from Marumsco Creek Wildlife Refuge as discussed in Section 6.1.

The following inorganics were detected in the thirty-three sediment samples and/or duplicate samples above both their respective site background concentrations and ER-L (where applicable): aluminum (site background concentration 15,200 µg/g) in six samples with the highest concentration detected at 21,200 µg/g in RISD36; barium (site background concentration 175 µg/g) in RISD36 and RISD44Dup at 236 µg/g and 185 µg/g, respectively; beryllium (site background concentration 1.26 µg/g) in three samples with the highest concentration detected in RISD36 at 1.67 µg/g; calcium (site background concentration 6,000 µg/g) in RISD41 at 8,870 µg/g; cobalt (site background value 20.7 µg/g) in five samples with the highest concentration detected 34.2 µg/g in RISD37; copper (site background concentration 41.8 µg/g) in six samples with the highest concentration of 62.2 µg/g detected in RISD6; iron (site background concentration 34,200 µg/g) in four samples with the highest concentration detected 45,100 µg/g in RISD23; lead (site background value 42.2 µg/g and ER-L 46.7 µg/g) in seven samples

with the maximum concentration detected of 75 µg/g in RISD6; magnesium (site background concentration 3,470 µg/g) in four samples with the maximum concentration of 4,090 detected in RISD41; nickel (site background concentration 30.9 µg/g and ER-L 20.9 µg/g) in three samples with a maximum concentration of 35.8 µg/g in RISD37; sodium (site background concentration 1,710 µg/g) in four samples with a maximum detected concentration of 2,790 µg/g; vanadium (site background concentration 52.5 µg/g) in twelve samples with a maximum detected concentration of 121 µg/g; and zinc (site background concentration 157 µg/g) in eight samples with a maximum detected concentration of 249 µg/g. The majority of these compounds were not significantly higher than the site background values. Inorganic compounds detected in sediment samples collected site-wide are presented in Table 7-38.

Benzo(a)pyrene was detected in eight sediment samples above the ER-L (0.088 µg/g) with a maximum detected concentration of 0.222 µg/g detected in RISD40. Additionally, TPH was detected in four sediment samples with the highest concentration (43 µg/g) detected in sample RISD23. No ER-L value exist for TPH in sediment, however, all of these detections were less than the Virginia action level of 100 µg/g for TPH in soil. Sample locations and analyte/compound concentrations are presented in Figure 7-18 and 7-19 for inorganic and organic compounds respectively. Organic compounds detected in the site wide sediment samples are presented in Table 7-39.

Aluminum was detected in seven surface water samples above site background (1,930 µg/L) and RBC for groundwater (3,700 µg/L) with a maximum detected concentration of 37,600 µg/L in RISW44Dup. Arsenic was detected in five surface water samples above the groundwater RBC (0.045 µg/L) with a maximum detected concentration of 2.5 µg/L. Chromium was detected in three surface water samples above RBC (18 µg/L) and site background (10.8 µg/L) with a maximum detected concentration of 38.1 µg/L in RISW45. Iron was detected above the site background value (2,500 µg/L) in 14 surface water samples with a maximum concentration of 32,900 µg/L detected in RISW45. Lead was detected above site background (1.9 µg/L) in the same 13 surface water samples with a maximum detected concentration of 16 µg/L in RISW45. Magnesium was detected in RISW4 above site background (7,500 µg/L) at 7,840 µg/L. Manganese was detected above site background (303 µg/L) in twelve surface water samples with a maximum detected concentration of 4,450 µg/L detected in RISW6Dup. Potassium was detected in 18 surface water samples above the site background (3,670 µg/L) with a maximum detected concentration of 6,760 µg/L in RISW44Dup. Sodium was detected above site background (16,500 µg/L) in three surface water samples with a maximum detected concentration of 21,900 µg/L detected in RISW4. Acetone, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, and fluoranthene were the only organic compounds detected in surface water samples. AWQC do not exist for these compounds in surface water. However, bis(2-ethylhexyl)phthalate was the only compound to be detected above RBC for groundwater (4.8 µg/L). It was detected in RISW2 and RISW9 at 5.5 µg/L and 25 µg/L, respectively. Sample locations and detected concentrations above background are presented in Figure 7-17. Inorganic and organic analytes detected in the site wide surface water samples are presented in Tables 7-40 and 7-41, respectively.

#### **7.6.4 Fish Tissue Residue Analysis of Samples Collected from Belmont, Occoquan Bay, Marumsco Creek, the Main Ditch and the Pond**

Biota samples were collected throughout WRF in Marumsco Creek, along the shorelines, in the pond and in the section of the Main Drainage Ditch near the Beaver Dam (refer to Figure 6-7). Thirty-six biota samples were collected as fillet and whole body samples by species. Samples were analyzed for lead, mercury, pesticides/PCBs, and PCTs. A detailed description of the biota sampling event is provided in the WRF Biota Sampling Report (USAEC, 1995d). The biota sampling program and results are discussed in more detail in Appendix A, Human Health Risk Assessments Appendix B, Ecological Risk Assessments of this report.

The following organic compounds were detected above RBCs in fish tissue samples: PCB-1260 was detected in 32 samples above the RBC (0.41 µg/g) with a maximum detected concentration of 1,090 µg/kg detected in EEL-3W from the ditch; DDE was detected in 30 samples above RBC (9.3 µg/g) with a maximum concentration of 88.1 µg/kg detected in CARP-1W from the ditch; DDD was detected in five

samples above RBC (13.0 µg/kg) with a maximum concentration of 325 µg/kg detected in CARP2-W from the ditch; alpha-chlordane was detected in 12 samples above RBC (2.4 µg/g) with a maximum detected concentration of 16.3 µg/kg detected in WPERCH-4W from Marumsco Creek; and gamma chlordane was detected in two samples above the RBC (2.4 µg/kg) with a maximum detected concentration of 5.85 µg/kg in CARP-24 from the ditch. Compounds detected in the site wide fish tissue samples are presented in Table 7-42.

### 7.6.5 Clam Tissue Analysis Results

Biota sampling was conducted at WRF during the last quarter of 1994. Aquatic Systems Corporation under the supervision of Earth Tech conducted the sampling. The goal of this sampling event was to collect, store, and analyze biota samples from the waters on and around WRF. The results of these data were used evaluate the potential for bioaccumulation of contaminants present at WRF. The fish data presented in the previous section was used in the human health and ecological risks assessments conducted for WRF. However, the clam data presented in the following sections has not been used in the risk assessments for the site.

The biota sampling included live clam box sampling from eight locations on and surrounding the WRF. The locations of the clam boxes are presented in Figure 6-8. The live clam box sampling was conducted from October 10, 1994 until December 6, 1994. The live clams were delivered to the site, placed in wire boxes, and distributed to the proper location. Eight locations were chosen as follows:

- Location 1: Marumsco Creek upstream of WRF,
- Location 2: Marumsco Creek adjacent to the western sewage sludge injection area,
- Location 3: Marumsco Creek adjacent to AREE 2/5,
- Location 4: Occoquan Bay near AREE 1,
- Location 5: Main Ditch just upstream of the Occoquan Bay,
- Location 6: Main Ditch downstream of the OU3 in an area known as the beaver pond,
- Location 7: Main Ditch on the eastern portion of OU3 just north of Charlie Road,
- Location 8: Belmont Bay 150 feet from the shoreline.

Prior to the clams being divided among the boxes and distributed to the waters on and surrounding the WRF, 40 clams were collected and prepared for analysis as a control. The control sample was analyzed and the results are presented in Table 7-43. The results from the analysis of the control sample indicated that the clams used in the experiment had detectable levels of the chemicals of concern at the WRF (e.g., pesticides and PCBs). Clams were collected from each location on a two week cycle for eight weeks. The data is presented in Table 7-43. The data includes the results for only one of the samples collected from each location. The data presented for Location 7 was from the analysis of dead clams. Because data for consecutive sampling times is not available for a single site, concentration rates or maximum concentrations could not be evaluated. Adjusted concentrations are shown on Table 7-43 which were derived from the difference between the concentrations detected in the control sample and that detected in the deployed clam box samples for the appropriate compound.

#### 7.6.5.1 Discussion of Results

The levels of PCBs and some pesticides decreased in the clams placed in Location 1, from the concentrations detected in the control. However, there was an increase in chlordane and its breakdown products and in some of the PAHs. Because Location 1 is upstream of WRF in Marumsco Creek, it is unlikely that WRF is the source area for the contaminants detected at this location. Also, the presence of these chemicals in the clams analyzed downstream from Location 1 may be attributable to off-site sources.

Chemicals detected in the clams collected from Location 2 included chlordane and its breakdown products and the PAHs, which were also detected in the clams collected from Location 1. Chemicals detected in the clams from Location 2 that were not present in the clams collected upstream were 4,4'-DDE and PCB-1260. DDT and its metabolites have been detected at low levels at WRF. It is possible

that the presence of 4,4'-DDE is from on-site as well as off-site locations. PCBs were detected at low levels from a sediment sample collected along the shoreline of Marumsco Creek near this clam box location.

The clams collected from Locations 3 and 4 had results similar to those observed in Location 2. The contaminants migrating from upstream locations in Marumsco Creek, e.g., chlordane, its breakdown products, and PAHs, were detected in the clams analyzed from Locations 3 and 4. The levels of PCB-1260 and 4,4'-DDE were elevated above the levels detected in the controls and from the clams placed in Location 1. Locations 3 and 4 are in the vicinity of AREE 2/5 and AREE 1, respectively. It is possible that the former dump areas are the source for some of the contamination in this area.

Location 5 had the lowest number of increases (compared to the controls) of chemicals of concern. There was no increase of PCBs or DDT in the clams collected from this location. This site is located downstream of OU3 in the Main Ditch and is the closest location to Belmont Bay. The results indicate that the contaminated sediments in OU3 and other areas within WRF have not impacted downstream locations in Marumsco Creek or the Occoquan Bay.

Location 6 is located upstream of Location 5 and downstream of OU3 in the Main Ditch. There was no increase of the levels of PCBs in the clams collected from this location. There was an increase in the level of 4,4'-DDE at this location. The clam boxes located upstream and downstream of this location did not show similar increases. PAHs were also elevated at this location.

Location 7 is located in OU3, near the area where the highest levels of PCBs were detected in the sediments. There was a significant increase in the level of PCBs in these clams. PAHs were also detected at concentrations greater than the control. Although this location was the site closest to the sediments where pesticides have been detected, there was no increase in the levels of pesticides measured in the clams collected from this location.

Location 8 followed the trend observed in the clams collected in Locations 2, 3, and 4. There was an increase in 4,4'-DDE and PCB-1260. There were also increases in some of the PAHs. However, this clam box was located in Belmont Bay along the northeastern facility boundary. No known disposal areas have been identified near this part of the facility that would be a source for PCBs. The compounds detected in this clam box location may be from off-site sources.

In summary, elevated levels of pesticides/PCBs and PAHs were detected during the live clam box study. The level of impact and/or amount of potential uptake from exposures to chemicals present at the site and surrounding areas cannot be assessed from this study. The following conclusions were drawn from the live clam box study. The level of chlordane in the clams analyzed from Location 1 indicates that there are off-site sources that have impacted this area. In addition, the PCBs detected at Location 8 may also be a result of off-site sources. Based on the results of chemicals, especially PCBs, detected in clams from Locations 3 and 4, migration from the former dump areas, AREE 2/5 and AREE 1 may be occurring. The accumulation of pesticides in the clams from location 6 may be attributable to pesticides detected in the surface soils collected in the vicinity of the Hunter Qualification Range. Because there were no pesticide increases observed in the clams collected from Location 5, it is assumed that the pesticides are either being degraded in the natural environment or move very slowly in the environment.

#### 7.6.6 Summary and Conclusions

The surface soils throughout the facility do not appear to be substantially impacted by past WRF activities. Nine inorganic compounds were detected in surface soil sample at concentrations exceeding the site background value. However, these exceedences are not significantly higher than the site background values. Only one organic constituent (PCB in RISS44) was detected above RBCs for soils. PCB-1248 and PCB-1254 were both detected in RISS44 at concentrations of 0.228 µg/g and 0.038 µg/g, respectively. The detections of PCBs in this sample can be attributed to one of the antenna fields (AREE 35) where it was collected. However, thirty organic compounds were detected in at least one surface soil sample. Many of these were detected in multiple samples and a few (especially PAHs) were detected in most of the samples. It should be noted that WRF is located in a highly urbanized and the compounds detected may be a result of off-site sources as well as on-site.

Site wide subsurface soils do not appear to have been impacted by past WRF activities. Seven inorganics were detected above site background values. None of these compounds were significantly higher than the site background values. There were nine organic compounds detected in PZ-9 at 10 feet bgs. None of these organics were detected in any other subsurface soil sample including the 5 feet bgs sample or the 15 feet bgs sample below from PZ-9. However, none of the organic compounds in subsurface soils exceeded their respective RBCs.

Site wide surface water does contain elevated levels of metals in some areas. Specifically, surface water samples northwest and northeast of the Main Compound (RISW26 through RISW29, RISW44, and RISW45) contain high concentrations of aluminum, arsenic, barium, chromium, copper, iron, lead, manganese, vanadium, and zinc. To a lesser degree, some surface water samples associated with the Main Drainage Ditch (RISW36 through RISW39) have somewhat elevated levels of many of the same metals. These samples were collected after and during major rain events and the elevated levels of metals has been attributed to suspended sediment in the water samples. No significant concentrations of organics were present in these surface water samples. Bis(2-ethylhexyl)phthalate was the only organic detected in surface water samples above RBCs.

Sediment samples collected site wide contained concentrations of inorganic compounds above site background values, and occurred sporadically throughout the site. The lack of trends within the metals detected and the fact that most of these detections were not significantly greater than the site background suggests that they may be naturally occurring.

In contrast, the numerous organic constituents detected are likely related to past WRF activities. Low concentrations of organics were detected in all of the sediment samples collected for the site wide investigation. However, benzo(a)pyrene was the only organic to have concentrations exceeding ER-L values. WRF is located in a highly urbanized area that may have contributed to the organic compounds, particularly PAHs

**Section 7.0**  
**Tables**



**Table 7-1**  
**Inorganic Compounds Detected in Background Surface Soil Samples**

Sample ID	Aluminum (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)
RIBKSS-1	14,600	3.85	ND	0.694	ND	26.7	6.46
RIBKSS-1Dup	14,100	ND	ND	0.576	ND	24.2	6.32
RIBKSS-2	6,550	ND	ND	0.364	486	9.72	12.7
RIBKSS-3	8,600	ND	67	0.712	918	18.4	9.77
RIBKSS-4	6,810	ND	ND	ND	764	14.5	6.83
RIBKSS-5	10,900	ND	73.4	0.785	1020	22.8	12

Sample ID	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
RIBKSS-1	7.77	23,900	17.2	1,290	119
RIBKSS-1Dup	7.11	22,200	15	1,260	104
RIBKSS-2	4.83	10,200	ND	881	412
RIBKSS-3	12.6	21,900	18	1,340	513
RIBKSS-4	5.72	12,700	15.5	1,250	266
RIBKSS-5	8.7	18,200	22.4	1,700	677

Sample ID	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
RIBKSS-1	7.42	567	ND	384	47	33.1
RIBKSS-1Dup	7.59	527	ND	391	43.4	31.4
RIBKSS-2	3.87	413	ND	380	20.6	14.8
RIBKSS-3	8.17	546	14.2	467	47.1	33.5
RIBKSS-4	5.21	358	ND	483	30.8	24.7
RIBKSS-5	8.98	597	ND	487	43	40.4

Surface soil samples collected were from background locations were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, PAHs, PCTs, TPH, and TAL metals.

-- No value available  
ND Not detected.

**Table 7-2**  
**Organic Compounds Detected in Background Surface Soil Samples**

Sample ID	Aldrin (µg/g)	Anthracene (µg/g)	Benzo(a) anthracene (µg/g)	Benzo(a)pyrene (µg/g)	Benzo(b) fluoranthene (µg/g)	Benzo (g,h,i) perylene (µg/g)
RIBKSS-1	ND	ND	ND	ND	0.002	ND
RIBKSS-1Dup	ND	ND	ND	ND	ND	ND
RIBKSS-2	0.003	ND	0.003	0.002	0.005	ND
RIBKSS-3	ND	0.027	0.005	0.006	0.01	0.011
RIBKSS-4	ND	0.028	0.004	0.006	0.009	0.011
RIBKSS-5	ND	0.015	0.005	0.008	0.009	0.011

Sample ID	Benzo(k) fluoranthene (µg/g)	Fluoranthene (µg/g)	Indeno (1,2,3-cd) pyrene (µg/g)	Methylene chloride (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)
RIBKSS-1	0.001	0.006	0.003	ND	0.341	ND
RIBKSS-1Dup	0.001	0.005	0.003	ND	0.347	ND
RIBKSS-2	0.002	0.006	0.008	ND	0.042	0.009
RIBKSS-3	0.005	0.018	0.009	ND	ND	0.017
RIBKSS-4	0.004	0.01	0.01	ND	ND	0.019
RIBKSS-5	0.005	0.012	0.008	0.02	ND	0.023

Surface soil samples collected from background locations were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, PAHs, PCTs, TPH, and TAL metals.

ND Not detected.

**Table 7-3**  
**Inorganics and Organics Detected in Subsurface Soil Samples**  
**(0 to 2 ft bgs) Collected in Background Locations**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)
MW-52	4,740	ND	0.3	149	9.42	2.47	7.41
MW-53	22,000	92.4	0.814	1,150	31.3	16.6	11.5
MW-54	14,300	72.3	0.79	822	26.8	14.5	8.75

Sample ID	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)
MW-52	7,630	ND	676	27.5	2.83	148	ND
MW-53	28,100	16.7	2,610	875	11.9	936	ND
MW-54	26,000	17.7	1,780	775	9.00	623	13.0

Sample ID	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)	Arsenic (µg/g)	Bis (2-ethylhexyl) phthalate (µg/g)
MW-52	439	19.9	15.2	--	ND
MW-53	404	58.9	43.9	3.24	0.18
MW-54	453	49.0	39.4	--	0.50

Subsurface soil samples (0 to 2 ft bgs) collected from Background Locations were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL Metals, and PCTs.

ND -- Not detected.

-- No value available.

**Table 7-4**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table)**  
**Collected in Background Locations**

Sample ID*	Depth bgs (ft)	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
MW-52	10	5,710	54.6	0.504	800	17.5
	17	2,000	ND	ND	562	3.66
MW-52 Dup	10	6,180	93.0	0.938	911	19.9
MW-53	10	2,660	ND	ND	113	4.24
	30	2,790	ND	ND	148	6.21
MW-54	5	18,200	67.4	1.02	454	25.0
	10	7,090	ND	0.346	265	11.7

Sample ID	Depth bgs (ft)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
MW-52	10	11.1	14.7	11,300	ND	2,870	161
	17	7.70	3.96	6,100	ND	768	145
MW-52 Dup	10	6.71	19.1	8,750	11.0	3,280	75.9
MW-53	10	ND	1.52	4,050	ND	366	51.8
	30	ND	2.30	2,490	ND	405	32.8
MW-54	5	13.9	14.0	27,800	11.8	3,700	617
	10	4.56	5.54	9,170	ND	1,670	100

Sample ID	Depth bgs (ft)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
MW-52	10	14.9	462	927	22.8	36.9
	17	4.40	135	600	10.2	14.5
MW-52 Dup	10	20.9	480	939	28.7	55.6
MW-53	10	ND	184	320	6.92	5.45
	30	ND	148	373	6.90	ND
MW-54	5	12.5	624	446	60.3	38.3
	10	5.41	351	361	20.3	17.6

Subsurface soil samples (2 ft bgs to water table) collected from background locations were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs.

ND Not detected.

**Table 7-5**  
**Inorganic Compounds Detected in Background Sediment Samples Collected from**  
**Mason Neck Wildlife Refuge**

Sample ID	Aluminum (µg/g)	Arsenic (µg/g)	Antimony (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Cadmium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)
RISDBK1	14,300	ND	ND	175	1.26	ND	6,000	29.9	20.7
RISDBK2	13,100	ND	ND	ND	1.11	ND	4,760	26.0	16.1
RISDBK3	16,900	ND	ND	ND	1.38	ND	5,070	33.7	21.4
RISDBK3 Dup	11,700	ND	ND	ND	1.06	ND	3,410	24.6	14.8
RISDBK4	15,200	ND	ND	ND	1.08	ND	5,990	30.1	18.0
RISDBK5	10,500	ND	ND	ND	0.989	ND	5,140	21.6	14.6

Sample ID	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Mercury (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)
RISDBK1	40.6	34,200	42.2	3,450	1,690	ND	30.0	1,850	ND
RISDBK2	33.3	30,000	30.6	2,810	1,470	ND	22.4	1,730	ND
RISDBK3	44.4	36,500	41.8	3,740	1,220	ND	30.3	2,090	ND
RISDBK3Dup	34.0	23,600	ND	2,740	603	ND	21.6	1,550	ND
RISDBK4	41.8	32,300	ND	3,470	1,220	ND	26.9	2,120	ND
RISDBK5	29.8	26,100	29	2,470	1,580	ND	19.3	1,450	ND

Sample ID	Silver (µg/g)	Sodium (µg/g)	Thallium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)	Carbon(TOC)
RISDBK1	ND	1,130	ND	51.5	139	5.02
RISDBK2	ND	1,240	ND	41.6	133	6.94
RISDBK3	ND	1,440	ND	54.1	168	10.1
RISDBK3Dup	ND	1,200	ND	39.6	128	5.63
RISDBK4	ND	1,710	ND	52.5	157	7.69
RISDBK5	ND	932	ND	35.5	114	4.46

Sediment samples collected were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH.

-- No value available.

ND Not detected.

**Table 7-6**  
**Organics Detected in Background Sediment Samples**  
**Collected from Mason Neck Wildlife Refuge**

Sample ID	1-Methyl naphthalene (µg/g)	Acenaphthene (µg/g)	Anthracene (µg/g)	Benzo(a) anthracene (µg/g)	Benzo(a) pyrene (µg/g)	Benzo(b) fluoranthene (µg/g)	Benzo(g,h,i) perylene (µg/g)
RISDBK1	ND	ND	ND	0.021	0.029	0.061	0.053
RISDBK2	ND	0.919	0.145	0.031	0.048	ND	ND
RISDBK3	0.93	ND	0.173	0.034	0.053	ND	0.09
RISDBK3 Dup	1.14	1.27	0.164	0.027	0.05	ND	0.07
RISDBK4	ND	ND	0.108	0.027	0.048	0.083	0.046
RISDBK5	0.498	ND	0.11	ND	0.028	0.05	ND

Sample ID	Benzo(k) fluoranthene (µg/g)	Dibenz(a,h) anthracene (µg/g)	Flour-anthene (µg/g)	Fluorene (µg/g)	Indeno (1,2,3-cd) pyrene (µg/g)	Methylene chloride (µg/g)	Naphthalene (µg/g)	Pyrene (µg/g)
RISDBK1	0.017	ND	0.055	ND	0.094	0.03	ND	0.053
RISDBK2	0.032	0.022	0.059	ND	0.112	ND	ND	0.085
RISDBK3	0.033	0.025	0.096	0.297	0.137	ND	ND	0.114
RISDBK3 Dup	0.029	0.016	0.092	ND	0.084	ND	0.636	0.108
RISDBK4	0.028	ND	0.094	0.355	0.094	ND	ND	0.116
RISDBK5	0.07	29.8	0.013	0.086	0.225	0.061	ND	0.13

Sediment samples collected from background locations were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH.

ND Not detected.

**Table 7-7**  
**Inorganic Compounds Detected in Background Surface Water Samples Collected from**  
**Mason Neck Wildlife Refuge**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Antimony (µg/L)	Barium (µg/L)	Beryllium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)
RISWBK1	1,860	1.4	ND	41.8	ND	ND	18,800	ND	ND
RISWBK2	1,840	ND	ND	41.3	ND	ND	19,300	10.8	ND
RISWBK3	1,440	ND	ND	36.9	ND	ND	20,400	ND	ND
RISWBK3Du	1,160	ND	ND	38.5	ND	ND	21,700	ND	ND
RISWBK4	1,230	ND	ND	40.4	ND	ND	22,200	ND	ND
RISWBK5	1,930	ND	ND	40.6	ND	ND	19,000	ND	ND

Sample ID	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Mercury (µg/L)	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)
RISWBK1	ND	2,460	1.6	6,120	236	ND	ND	3,350	ND
RISWBK2	ND	2,500	1.9	6,100	196	ND	ND	3,670	ND
RISWBK3	ND	1,810	1.3	6,350	159	ND	ND	3,490	ND
RISWBK3Dup	ND	2,000	1.3	6,880	226	ND	ND	2,990	ND
RISWBK4	ND	2,020	1.4	7,500	303	ND	ND	2,870	ND
RISWBK5	ND	2,510	1.9	5,970	176	ND	ND	3,300	ND

Sample ID	Silver (µg/L)	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)	Alkalinity	Hardness	Residue Suspended (TSS)
RISWBK1	ND	13,000	ND	ND	ND	40	76.6	54
RISWBK2	ND	12,900	ND	ND	ND	50	80	41
RISWBK3	ND	13,100	ND	ND	ND	55	84	39
RISWBK3Dup	ND	14,300	ND	ND	ND	59	85.2	37
RISWBK4	ND	16,500	ND	ND	ND	63	93.6	28
RISWBK5	ND	12,500	ND	ND	ND	50	81.6	68

Surface water samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH.

ND Not detected.

-- No value available.

**Table 7-8**  
**Inorganics Detected In Background Groundwater Samples**  
**Round 1 & 2**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)
Round 1							
MW-52	94.8	ND	107	ND	9,680	ND	ND
MW-53	12,500	1.1	74.9	0.8	5,450	22.3	ND
MW-54	117	ND	ND	0.1	2,250	ND	ND
MW-63	635	1.6	30.8	ND	24,300	ND	ND
Round 2							
MW-52	234	ND	98	ND	8,090	ND	ND
MW-53	293	ND	51.1	ND	5,420	ND	ND
MW-54	144	ND	ND	0.3	2,400	ND	ND
MW-63	780	6.9	30.3	ND	42,800	ND	ND
MW-63 Dup	514	6.5	27.2	0.2	41,600	ND	ND

Sample ID	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)
Round 1							
MW-52	ND	159	ND	6,030	60.8	18.4	1,450
MW-53	8.9	9,620	6.3	6,830	354	ND	6,490
MW-54	ND	194	ND	1,810	47.2	ND	ND
MW-63	ND	433	ND	3,580	12.0	ND	14,000
Round 2							
MW-52	ND	455	ND	5,940	48.4	ND	1,360
MW-53	ND	179	ND	7,720	18.9	ND	8,190
MW-54	ND	196	ND	2,020	35.2	ND	744
MW-63	ND	532	ND	225	10.8	ND	20,900
MW-63 Dup	ND	209	1.2	157	ND	ND	20,300



**Table 7-8 (Continued)**  
**Inorganics Detected In Background Groundwater Samples**  
**Round 1 & 2**

Sample ID	Selenium (µg/L)	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
Round 1					
MW-52	2.1	16,600	ND	ND	46.0
MW-53	4.2	5,110	0.1	21.2	23.0
MW-54	ND	5,610	ND	ND	ND
MW-63	2.7	41,300	ND	12.3	ND
Round 2					
MW-52	ND	23,600	ND	ND	20.3
MW-53	ND	6,850	ND	ND	ND
MW-54	ND	5,720	ND	ND	ND
MW-63	ND	44,300	ND	31.4	ND
MW-63 Dup	ND	42,700	ND	28.2	ND

Groundwater samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH.

ND Not detected

-- No value available

**Table 7-9**  
**Organics Detected In Background Groundwater Samples**  
**Round 1 & 2**

Sample ID	1-Methyl naphthalene (µg/L)	2-Methyl naphthalene (µg/L)	Acenaphthene (µg/L)	Acenaphthylene (µg/L)	Anthracene (µg/L)	BHC,B (µg/L)
Round 1						
MW-52	ND	ND	ND	ND	0.113	ND
MW-53	ND	ND	ND	ND	ND	ND
MW-54	ND	ND	ND	ND	ND	ND
MW-63	119	80.5	11.0	6.34	ND	ND
Round 2						
MW-52	ND	ND	ND	ND	ND	ND
MW-53	ND	ND	ND	ND	ND	ND
MW-54	ND	ND	ND	ND	ND	ND
MW-63	101	79.3	4.17	3.01	2.00	0.017
MW-63Dup	ND	78.8	8.27	ND	ND	ND

Sample ID	BHC,G (Lindane) (µg/L)	Dieldrin (µg/L)	Dimethyl phthalate (µg/L)	Endosulfan, B (µg/L)	Endosulfan sulfate (µg/L)	Endrin (µg/L)
Round 1						
MW-52	ND	ND	ND	ND	0.146	ND
MW-53	ND	ND	ND	ND	ND	ND
MW-54	ND	ND	ND	ND	ND	ND
MW-63	ND	ND	ND	0.021	0.027	0.022
Round 2						
MW-52	ND	ND	ND	ND	0.138	ND
MW-53	ND	ND	ND	ND	ND	ND
MW-54	ND	ND	ND	ND	ND	ND
MW-63	0.098	0.026	ND	ND	0.019	ND
MW-63Dup	ND	0.018	3.90	ND	ND	ND

**Table 7-9 (continued)**  
**Organics Detected In Background Groundwater Samples**  
**Round 1 & 2**

Sample ID	Ethylbenzene (µg/L)	Fluoranthene (µg/L)	Flourene (µg/L)	Heptachlor (µg/L)	Naphthalene (µg/L)	Phenanthren e(µg/L)	Pyrene (µg/L)
Round 1							
MW-52	ND	ND	ND	ND	ND	ND	ND
MW-53	ND	ND	ND	ND	ND	ND	ND
MW-54	ND	ND	ND	ND	ND	ND	ND
MW-63	13	0.063	3.2	ND	30	8.69	0.158
Round 2							
MW-52	ND	ND	ND	ND	ND	ND	ND
MW-53	ND	ND	ND	ND	ND	ND	ND
MW-54	ND	ND	ND	ND	ND	ND	ND
MW-63	5.30	0.069	1.87	ND	18.0	6.43	0.162
MW-63Dup	5.20	0.069	2.01	0.011	15.2	6.35	0.137

Sample ID	Toluene (µg/L)	TPH, As Diesel (µg/L)	TPH, As Gas (µg/L)	Xylenes (µg/L)
Round 1				
MW-52	ND	ND	ND	ND
MW-53	ND	ND	ND	ND
MW-54	ND	ND	ND	ND
MW-63	5.2	900	740	54
Round 2				
MW-52	ND	ND	ND	ND
MW-53	ND	ND	ND	ND
MW-54	ND	ND	ND	ND
MW-63	2.30	1,140	558	32.0
MW-63Dup	2.10	1,130	538	31.0

Groundwater samples collected were analyzed for TCL VOCs, SVOCs, Pesticides/PCBs, TAL Metals, PAHs, and PCTs.

ND Not detected.

**Table 7-10**  
**Summary of RI Results for AREE 1 - Former Dump No. 1**

Media Sampled <sup>a</sup>	Number of Samples Collected	Compounds/Analytes Detected above LOC <sup>b</sup>	Summary of Fate & Transport
Surface Soil	8	Al, Be, Ca, Cr, Cu, Co, Fe, Pb, Hg, K, Na, Zn  benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(a,h)anthracene, indeno(1,2,3-cd)pyrene,  PCB-1260	Infiltration/percolation through soil to groundwater  Storm water runoff to surface water/sediments
Subsurface Soil (0- to 2-ft bgs)	6	Ba, Be, Ca, Cr, Co, Hg, Pb, Mg, Ni, K, Na, V, Zn  PCB-1260	
Subsurface Soil (2-ft bgs to water table)	10	Be, Ca, Co, Pb, V  PCB-1260	
Test Pits	5	Ba, Ca, Fe, Pb, K, V	
Groundwater	Round 1 - 11 Round 2 - 5	Al, Ba, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, Se, Ti, V, Zn	Discharge to surface water
Sediment	8	Ag, Co, Cr, Fe, Na, V, Zn,  PCB-1260	Leaching to surface water
Surface Water	8	Al, Ba, Cr, Cu, Fe, Pb, Mn, K, V, Zn	Uptake into aquatic plants and animals
Surface Water Runoff	5	None	Overland flow

<sup>a</sup> Surface soil, subsurface soil, test pit, and groundwater samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs. Surface soil and groundwater samples were also analyzed for PAHs.

<sup>b</sup> LOC - Level of Concern. Refers to either the WRF site background maximum concentrations for inorganics detected in all media or USEPA Region III residential risk-based concentrations for organics detected in all media.

**Table 7-10 (Continued)**  
**Inorganics Detected in Surface Soil Samples Collected in AREE 1**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)
Site Background <sup>a</sup>	14,350	92.4	0.814	1,150	31.3	16.6
RISS1	14,200	ND	0.735	1,050	24.2	8.06
RISS1DUP	11,700	ND	0.896	1,130	22.8	7.35
RISS2	11,400	ND	0.651	1,050	24.3	6.16
RISS3	13,300	53	0.639	3,580	24.5	4.70
RISS4	13,100	59.6	0.755	2,260	25	6.30
RISS54	14,700	ND	0.669	679	25.8	6.86
RISS55	11,400	62.7	0.544	1,640	96.7	5.81
RISS56	9,640	ND	0.506	1,470	19.4	20.4

Sample ID	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Mercury (µg/g)
Site Background <sup>a</sup>	12.6	28,100	22.4	2,610	876	ND
RISS1	18.1	25,400	24.3	2,370	180	ND
RISS1DUP	20.7	27,100	35.7	2,030	173	ND
RISS2	12.3	16,500	12	1,990	53.8	ND
RISS3	9.59	37,000	ND	1,090	50.6	ND
RISS4	14.7	22,800	31.9	1,590	169	0.121
RISS54	8.69	24,900	13.1	1,810	129	ND
RISS55	10.6	17,300	25.1	1,550	137	ND
RISS56	10.2	17,500	28.3	1,330	238	ND

Sample ID	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	11.9	936	487	58.9	43.9
RISS1	11.2	990	991	37.4	177
RISS1DUP	10.6	828	550	35.2	231
RISS2	9.34	749	467	42.8	34.3
RISS3	5.88	554	530	47.6	23.3
RISS4	9.60	711	492	43.3	135
RISS54	8.47	553	311	48.3	29.9
RISS55	10.3	615	298	35.5	195
RISS56	6.88	703	271	34.3	301

ND Not Detected.

<sup>a</sup> Site background concentrations are from surface soil samples MW-52 through MW-54 and RIBKSS1 through RIBKSS5.

**Table 7-10 (Continued)**  
**Organics Detected in Surface Soil Samples Collected in AREE 1**

Sample ID	1-Methyl naphthalene (µg/g)	2-Methyl naphthalene (µg/g)	Acenaphthene (µg/g)	Anthracene (µg/g)	Benzo(a) anthracene (µg/g)
RBC*	230*	230*	470	2,300	0.88
RISS1	ND	ND	ND	0.022	ND
RISS1DUP	ND	ND	ND	0.081	ND
RISS2	ND	ND	ND	0.009	0.004
RISS3	ND	ND	ND	ND	ND
RISS4	ND	0.189	ND	0.160	ND
RISS54	ND	ND	ND	ND	0.002
RISS55	0.383	2.98	6.29	4.12	0.999
RISS56	0.842	6.05	10.8	11.7	2.0

Sample ID	Benzo(a)pyrene (µg/g)	Benzo(b) fluoranthene (µg/g)	Benzo(g,h,i) perylene (µg/g)	Benzo(k) fluoranthene (µg/g)	Bis(2- ethylhexyl)- phthalate (µg/g)	Chlordane (µg/g)
RBC*	0.088	0.88	230*	0.8	46	0.49
RISS1	0.002	0.002	ND	ND	1.70	ND
RISS1DUP	0.004	0.003	ND	0.002	0.730	ND
RISS2	0.006	0.006	ND	0.003	0.340	ND
RISS3	0.002	0.003	ND	0.001	0.460	ND
RISS4	0.090	ND	0.045	ND	1.40	ND
RISS54	0.004	0.004	ND	0.002	ND	ND
RISS55	1.03	1.09	1.13	0.536	ND	0.025
RISS56	0.37	2.19	2.77	1.20	ND	ND

**Table 7-10 (Continued)**  
**Organics Detected in Surface Soil Samples Collected in AREE 1**

Sample ID	Chrysene (µg/g)	DDD (µg/g)	DDE (µg/g)	DDT (µg/g)	Dibenzo(a,h) anthracene (µg/g)	Fluoranthene (µg/g)
RBC <sup>a</sup>	88	2.7	1.9	1.9	0.088	310
RISS1	ND	0.011	ND	ND	ND	0.004
RISS1DUP	0.010	ND	ND	0.004	ND	0.011
RISS2	ND	ND	ND	ND	ND	0.007
RISS3	ND	ND	ND	ND	ND	0.003
RISS4	0.048	0.005	0.006	ND	0.022	0.201
RISS54	ND	ND	ND	ND	ND	0.007
RISS55	1.07	0.024	0.008	0.056	0.287	2.52
RISS56	2.62	0.006	0.052	0.035	0.698	0.34

Sample ID	Fluorene (µg/g)	Indeno(1,2,3- cd)pyrene (µg/g)	Napthalene (µg/g)	PCB-1280 (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)
RBC <sup>a</sup>	310	0.88	310	0.083 <sup>b</sup>	230 <sup>c</sup>	230
RISS1	ND	ND	ND	0.149	ND	ND
RISS1DUP	ND	ND	ND	0.037	ND	0.034
RISS2	ND	ND	ND	ND	ND	0.009
RISS3	ND	ND	ND	ND	ND	ND
RISS4	ND	0.038	ND	0.713	0.223	0.197
RISS54	ND	ND	0.332	ND	ND	ND
RISS55	0.487	0.707	1.80	0.279	2.36	3.33
RISS56	0.755	1.70	4.37	0.054	6.29	12.3

ND Not detected.

<sup>a</sup> The maximum detected concentrations of organic and inorganic compounds were compared to USEPA Region III residential RBCs, in accordance with Region III guidance (USEPA, 1996a). The RBCs are health-protective chemical concentrations that are back-calculated using toxicity criteria, a  $1 \times 10^{-6}$  target risk level or a 0.1 hazard index, and conservative exposure parameters.

<sup>b</sup> Value is for carcinogenic PCBs.

<sup>c</sup> The RBC for pyrene was used as a surrogate for non-carcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

**Table 7-10 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (0 to 2 ft bgs) Collected in AREE 1**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)
Site Background <sup>a</sup>	14,350	92.4	0.814	1,150	31.3	16.6	12.6
MW-76	1,890	ND	ND	463	15.3	4.93	4.79
MW-77	7,430	50.8	0.68	900	27.2	12.1	14.1
MW-77DUP	10,200	85.7	0.70	1,090	33.0	14.4	15.7
MW-78	4,620	ND	0.40	1,240	20.3	6.92	8.40
MW-79	11,200	ND	1.20	373	24.4	6.46	11.5
MW-80	7,880	49.9	0.50	2,530	16.8	6.96	12.3

Sample ID	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Mercury (µg/g)	Nickel (µg/g)	Potassium (µg/g)
Site Background <sup>a</sup>	28,100	22.4	2,610	875	ND	11.9	936
MW-76	10,200	10.4	377	190	0.209	4.33	217
MW-77	17,200	13.0	3,430	117	ND	16.4	682
MW-77DUP	16,000	10.2	3,950	119	ND	18.7	899
MW-78	14,100	24.5	1,010	322	ND	7.39	460
MW-79	26,800	12.9	2,830	63.8	ND	8.80	394
MW-80	17,700	32.4	1,400	216	ND	8.65	603

Sample ID	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	14.2	487	68.9	43.9
MW-76	ND	409	25.5	17.4
MW-77	17.4	579	35.7	37.5
MW-77DUP	ND	638	43.6	41.4
MW-78	13.4	395	38.0	45.4
MW-79	ND	982	54.4	32.6
MW-80	15.4	480	32.1	61.3

ND Not detected.

<sup>a</sup> Background concentrations are from soil samples MW-52 through MW-54 and RIBKSS1 through RIBKSS5.



**Table 7-10 (Continued)**  
**Organics Detected in Subsurface Soil Samples (0 to 2 ft bgs) Collected in AREE 1**

Sample ID	Benzo(b) fluoranthene (µg/g)	Chrysene (µg/g)	DDD (µg/g)	DDE (µg/g)	Dieldrin (µg/g)	Endosulfan sulfate (µg/g)
RBC <sup>a</sup>	0.88	88	2.7	1.9	0.04	47 <sup>b</sup>
MW-76	ND	ND	ND	ND	ND	ND
MW-77	ND	ND	ND	ND	ND	ND
MW-77DUP	ND	ND	ND	ND	ND	0.03
MW-78	0.20	0.17	ND	ND	ND	ND
MW-79	ND	ND	ND	ND	ND	ND
MW-80	ND	ND	0.01	0.01	0.02	ND

Sample ID	Fluoranthene (µg/g)	PCB-1260 (µg/g)	Pyrene (µg/g)
RBC <sup>a</sup>	310	0.083 <sup>c</sup>	230
MW-76	ND	ND	ND
MW-77	ND	ND	ND
MW-77DUP	ND	ND	ND
MW-78	0.19	0.11	0.20
MW-79	ND	ND	ND
MW-80	0.91	10.8	0.85

ND Not detected.

<sup>a</sup> RBC values are from USEPA Region III Residential Soil RBCs. RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

<sup>b</sup> The RBC for endosulfan was used.

<sup>c</sup> Value is for carcinogenic PCBs.

**Table 7-10 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table) Collected in AREE 1**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background*		18,200	73.8	ND	454	25
MW-76	5	3,140	ND	0.390	726	18.4
	7	4,480	ND	0.499	653	17.1
MW-77	5	3,190	ND	ND	190	8.96
	7	3,680	ND	0.27	228	10.7
MW-78	5	1,780	ND	0.34	145	5.41
	10	1,930	ND	ND	193	4.32
MW-79	5	7,240	ND	0.39	295	13.8
	10	2,630	ND	ND	140	5.35
MW-80	5	6,150	50.6	0.47	702	15.7
	10	2,180	ND	ND	138	4.70

Sample ID	Depth bgs (ft)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background*		13.9	16.9	27,800	11.8	3,700	617
MW-76	5	14.4	8.50	13,200	11.3	784	138
	7	9.23	8.00	11,400	ND	1,230	108
MW-77	5	ND	2.28	3,200	ND	751	29.3
	7	2.89	4.62	12,600	ND	685	93.3
MW-78	5	ND	2.58	11,800	ND	308	77.1
	10	ND	2.17	2,350	ND	352	40.1
MW-79	5	3.86	5.73	4,410	ND	1,470	43.5
	10	ND	2.44	2,650	ND	438	17.4
MW-80	5	10.3	10.7	10,400	ND	1,380	115
	10	ND	2.65	4,200	ND	340	43.0

**Table 7-10 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table) Collected in AREE 1**

Sample ID	Depth bgs (ft)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>		17.9	624	933	25.8	46.3
MW-76	5	6.15	320	466	37.2	20.1
	7	8.03	575	547	27.7	22.1
MW-77	5	4.28	341	302	7.06	8.78
	7	3.90	340	436	10.6	12.0
MW-78	5	ND	ND	262	6.49	8.08
	10	ND	149	249	6.49	ND
MW-79	5	5.57	330	417	21.5	18.8
	10	ND	191	247	8.27	ND
MW-80	5	7.59	568	422	30.1	23.5
	10	ND	ND	250	6.37	ND

ND Not detected.

<sup>a</sup> Background concentrations are from samples MW-52 through MW-54, each at two depths.

**Table 7-10 (Continued)**  
**Organic Compounds Detected In Subsurface Soil Samples (2 ft bgs to Water Table)**  
**Collected In AREE 1**

Sample ID	Depth bgs (ft)	Acetone (µg/g)	Bis(2-ethylhexyl) phthalate (µg/g)	Endosulfan Sulfate (µg/g)	Fluoranthene (µg/g)	Methoxychlor (µg/g)
RBC <sup>a</sup>		780	46	47 <sup>b</sup>	310	39
MW-76	5	ND	ND	ND	0.33	ND
	7	0.02	ND	ND	ND	ND
MW-77	5	ND	0.17	0.01	ND	ND
	7	0.01	ND	ND	ND	ND
MW-78	10	0.03	ND	ND	ND	ND
MW-79	10	0.01	0.29	ND	ND	ND
MW-80	5	0.02	ND	ND	ND	ND
	10	ND	6.50	ND	ND	0.01

Sample ID	Depth bgs (ft)	PCB-1260 (µg/g)	Pyrene (µg/g)
RBC <sup>a</sup>		0.083 <sup>c</sup>	230
MW-76	5	ND	0.28
	7	ND	ND
MW-77	5	ND	ND
	7	ND	ND
MW-78	10	ND	ND
MW-79	10	ND	ND
MW-80	5	1.62	ND
	10	ND	ND

ND Not detected.

<sup>a</sup> USEPA Region III residential risk-based concentration (RBC) values. RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

<sup>b</sup> The RBC for endosulfan was used.

<sup>c</sup> Value is for carcinogenic PCBs.

**Table 7-10 (Continued)**  
**Inorganics Detected in Test Pit Samples Collected in AREE 1**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background <sup>a</sup> (0 ft bgs)		14,350	92.4	0.814	1,150	31.3
Site Background <sup>b</sup> (2 ft bgs)		18,200	73.8	1.02	454	25.0
TP-1A	0	11,900	ND	ND	967	18.3
TP-1ADUP	0	10,900	ND	0.312	1,120	17.9
TP-1B	2	11,400	ND	0.725	697	20.3
TP-2A	2	13,600	ND	0.320	571	20.8
TP-2B	2	12,700	75.2	0.539	476	17.7

Sample ID	Depth bgs (ft)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)
Site Background <sup>a</sup> (0 ft bgs)		16.6	12.8	28,100	22.4	2,610
Site Background <sup>b</sup> (2 ft bgs)		13.9	16.9	27,800	11.8	3,700
TP-1A	0	4.17	8.61	21,500	10.7	1,040
TP-1ADUP	0	4.02	9.30	23,600	12.0	1,060
TP-1B	2	8.47	13.9	29,200	12.5	1,850
TP-2A	2	7.28	8.19	17,200	25.0	1,500
TP-2B	2	6.98	11.7	17,100	20.3	765

Sample ID	Depth bgs (ft)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup> (0 ft bgs)		876	11.9	936	487	58.9	43.9
Site Background <sup>b</sup> (2 ft bgs)		617	17.9	624	933	25.8	46.3
TP-1A	0	36.6	5.66	457	361	32.8	30.0
TP-1ADUP	0	36.4	5.65	363	419	41.3	25.1
TP-1B	2	110	10.1	629	538	33.2	37.9
TP-2A	2	163	8.02	916	492	36.0	35.8
TP-2B	2	262	6.59	573	380	33.9	37.0

ND Not detected.

<sup>a</sup> Background concentrations are from soil samples MW-52 through MW-54 and RIBKSS1 through RIBKSS5.

<sup>b</sup> Background concentrations are from soil samples MW-52 through MW-54, each at two depths.

**Table 7-10 (Continued)**  
**Organics Detected in Test Pit Samples Collected in AREE 1**

Sample ID	Depth bgs (ft)	Bis(2-ethylhexyl)-phthalate (µg/g)	DDD (µg/g)	DDE (µg/g)	Methoxychlor (µg/g)
RBC <sup>a</sup>		46	2.7	1.9	39
TP-1A	0	0.160	ND	ND	ND
TP-1AD	0	ND	ND	ND	ND
TP-1B	2	ND	ND	ND	ND
TP-2A	2	ND	0.009	0.008	ND
TP-2B	2	ND	0.005	0.017	ND

ND Not detected.

<sup>a</sup> USEPA Region III residential risk-based concentration (RBC) values. RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

**Table 7-10 (Continued)**  
**Inorganics Detected In Groundwater Samples Collected In AREE 1**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)
Site Background*	12,500	6.70	107	0.800	42,200	22.3	ND
MW-7	85,000	4.1	324	0.5	21,700	1,120	73
MW-8	209	ND	ND	0.1	1,190	ND	ND
MW-9	56.9	ND	123	ND	49,200	ND	ND
MW-10	1,090	ND	73.9	ND	17,000	31.6	ND
MW-11	380	1.9	111	ND	22,300	ND	ND
MW-12	1,510	ND	43	ND	17,900	ND	ND
MW-76	157	ND	43.5	ND	24,300	ND	ND
MW-76 Round 2	307	ND	29.1	ND	16,700	ND	ND
MW-77	170	ND	27.9	0.1	7,820	ND	ND
MW-77 Round 2	2,780	ND	42.0	0.1	9,530	ND	ND
MW-78	593	ND	48.4	ND	13,600	ND	27.4
MW-78 Round 2	5,750	ND	63.9	ND	15,100	ND	ND
MW-79	209	2.7	34.5	ND	7,980	ND	30.7
MW-79 Round 2	1,000	2.8	29.4	ND	6,970	ND	22.4
MW-80	68	ND	ND	ND	2,920	ND	ND
MW-80 Round 2	1,430	ND	25.3	ND	3,960	ND	ND

**Table 7-10 (Continued)**  
**Inorganics Detected In Groundwater Samples Collected In AREE 1**

Sample ID	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)
Site Background*	8.9	9,620	6.3	7,720	354	18.4	20,600
MW-7	124	109,000	54.6	35,300	1,610	706	8,160
MW-8	ND	216	7.3	1,410	26	ND	568
MW-9	ND	73,700	ND	21,400	5,160	ND	2,330
MW-10	5.5	38,600	48	9,300	1,900	20.5	2,070
MW-11	ND	30,300	7.2	11,600	2,850	ND	1,120
MW-12	ND	3,020	2	4,830	252	ND	3,600
MW-76	ND	13,500	ND	8,710	1,050	ND	1,500
MW-76 Round 2	ND	11,400	ND	5,540	994	ND	1,880
MW-77	ND	340	ND	4,440	304	ND	1,270
MW-77 Round 2	5.9	6,050	1.6	8,120	328	ND	1,740
MW-78	ND	690	ND	11,100	970	ND	805
MW-78 Round 2	6.1	7,840	2.4	12,400	1350	ND	1,290
MW-79	ND	15,200	ND	9,170	609	ND	779
MW-79 Round 2	ND	17,600	ND	7,920	479	ND	1,430
MW-80	ND	343	ND	2,440	165	ND	678
MW-80 Round 2	ND	3,510	ND	3,250	285	ND	1,210



**Table 7-10 (Continued)**  
**Inorganics Detected In Groundwater Samples Collected In AREE 1**

Sample ID	Selenium (µg/L)	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
Site Background <sup>a</sup>	4.2	43,500	0.1	29.3	46
MW-7	5.1	26,600	1.7	259	267
MW-8	ND	14,700	ND	ND	135
MW-9	ND	31,200	ND	ND	49.4
MW-10	ND	31,000	ND	ND	228
MW-11	ND	24,300	ND	ND	107
MW-12	ND	8,950	ND	ND	ND
MW-76	ND	25,500	ND	ND	ND
MW-76 Round 2	ND	11,700	ND	ND	ND
MW-77	2.1	22,100	ND	ND	ND
MW-77 Round 2	ND	20,800	ND	ND	ND
MW-78	4.2	22,400	ND	ND	ND
MW-78 Round 2	ND	24,600	ND	16.9	20.0
MW-79	3.5	20,700	ND	ND	ND
MW-79 Round 2	ND	17,800	ND	ND	ND
MW-80	3	12,400	ND	ND	ND
MW-80 Round 2	3.0	14,400	ND	ND	ND

ND Not detected.

<sup>a</sup> Site background concentrations are from samples MW-52 through MW-54, and MW-63, which were sampled in two rounds.

<sup>b</sup> Round 2 sampling was conducted in March 1996.

**Table 7-10 (Continued)**  
**Organics Detected In Groundwater Samples Collected In AREE 1**

Sample ID	2-Methyl naphthalene (µg/L)	Acenaphthene (µg/L)	Acenaphthylene (µg/L)	Acetone (µg/L)	Anthracene (µg/L)	Alpha, BHC (µg/L)
RBC*	110 <sup>b</sup>	220	110 <sup>b</sup>	370	1,100	0.011
MW-7	ND	ND	17.3	ND	ND	ND
MW-8	ND	ND	ND	ND	ND	ND
MW-9	ND	ND	ND	ND	ND	ND
MW-10	ND	ND	ND	ND	ND	ND
MW-11	ND	ND	ND	ND	ND	ND
MW-12	ND	ND	ND	23	ND	ND
MW-76	ND	ND	ND	ND	ND	ND
MW-76 Round 2	ND	ND	ND	ND	ND	0.008
MW-77	6.2	6.34	ND	ND	ND	ND
MW-77 Round 2	ND	ND	ND	ND	ND	ND
MW-78	ND	ND	ND	ND	ND	0.006
MW-78 Round 2	ND	ND	ND	11	ND	ND
MW-79	ND	ND	ND	ND	0.595	0.006
MW-79 Round 2	ND	ND	ND	ND	ND	0.008
MW-80	ND	ND	ND	ND	ND	ND
MW-80 Round 2	ND	ND	ND	ND	ND	0.008

**Table 7-10 (Continued)**  
**Organics Detected In Groundwater Samples Collected In AREE 1**

Sample ID	BHC,G(Lindane) (µg/L)	Bis(2- ethylhexyl) phthalate (µg/L)	Chrysene (µg/L)	Delta BHC (µg/L)	Endosulfan sulfate (µg/L)	Fluoranthene (µg/L)
RBC <sup>a</sup>	0.052	4.8	9.2	NA	22 <sup>c</sup>	150
MW-7	ND	ND	ND	ND	ND	0.032
MW-8	ND	ND	ND	ND	0.044	ND
MW-8 Round 2	ND	NS	NS	ND	NS	NS
MW-9	ND	2.6	ND	ND	ND	ND
MW-9 Round 2	ND	NS	NS	ND	NS	NS
MW-10	ND	4.2	ND	ND	ND	ND
MW-11	ND	5.2	ND	ND	ND	ND
MW-11 Round 2	ND	NS	NS	ND	NS	NS
MW-12	ND	ND	ND	ND	ND	ND
MW-76	ND	ND	ND	ND	ND	ND
MW-76 Round 2	0.007	ND	ND	0.007	ND	ND
MW-77	ND	6.9	0.188	ND	ND	0.037
MW-77 Round 2	ND	5.3	ND	ND	ND	ND
MW-78	ND	ND	ND	ND	ND	0.024
MW-78 Round 2	ND	ND	ND	ND	ND	ND
MW-79	ND	2.5	ND	ND	ND	0.025
MW-79 Round 2	ND	ND	ND	ND	ND	ND
MW-80	ND	2.2	ND	ND	ND	ND
MW-80 Round 2	ND	ND	ND	ND	0.018	ND

ND Not detected.

NA Not available.

-- No value available.

<sup>a</sup> The groundwater and surface water RBC values are from USEPA Region III Tap Water RBCs (USEPA 1996<sub>a</sub>). RBCs for carcinogenic chemicals are based on a hazard quotient of 1.0, following USEPA Region III guidance.

<sup>b</sup> The RBC for pyrene was used as a surrogate for non-carcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>c</sup> The RBC for endosulfan was used.

**Table 7-10 (Continued)**  
**Inorganics Detected In Sediment Samples Collected In AREE 1**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)
Site Background*	15,200	175	1.26	6,000	30.1	20.7	41.8
RISD14	1,360	ND	ND	246	9.4	2.73	3.11
RISD15	1,900	ND	ND	436	10.3	4.28	4.1
RISD16	3,340	ND	0.459	1,160	10.9	6.21	9.81
RISD17	2,490	ND	0.316	585	10.7	5.98	5.21
RISD18	1,870	ND	0.397	1,360	9.7	7.19	6.21
RISD19	964	ND	ND	214	5.2	7.28	4.65
RISD20	10,300	ND	ND	5,420	23	12	36.9
RISD21	6,700	ND	0.967	856	34.9	29.4	28.1

Sample ID	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)
Site Background*	34,200	42.2	3,740	1,690	30.0	2,120
RISD14	8,160	ND	256	125	2.78	181
RISD15	8,980	ND	563	525	4.68	243
RISD16	11,100	14.8	799	383	6.41	492
RISD17	10,200	11	835	388	6.59	372
RISD18	12,700	10.6	515	529	5.27	270
RISD19	6,530	ND	227	142	2.53	ND
RISD20	22,500	ND	2,910	895	22.2	1,140
RISD21	48,500	ND	1,750	585	20.4	565

**Table 7-10 (Continued)**  
**Inorganics Detected In Sediment Samples Collected In AREE 1**

Sample ID	Silver (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	ND	1,710	52.5	157
RISD14	ND	365	21.4	20.1
RISD15	ND	364	22.3	29.5
RISD16	ND	519	19.3	42
RISD17	3.45	385	20.6	27.5
RISD18	ND	440	24.3	34.4
RISD19	ND	411	13.5	15.5
RISD20	ND	2,290	56.7	158
RISD21	ND	965	112	71.7

ND Not detected.

<sup>a</sup> Site background concentrations are from samples RISDBK1 through RISDBK5.

**Table 7-10 (Continued)**  
**Organics Detected In Sediment Samples Collected In AREE 1**

Sample ID	2-Methyl-naphthalene (µg/g)	Acenaphthene (µg/g)	Acetone (µg/g)	Anthracene (µg/g)	Benzo(a) anthracene (µg/g)	Benzo(a)pyrene (µg/g)
RBC*	230 <sup>b</sup>	470	780	2,300	0.88	0.088
RISD14	ND	ND	ND	ND	ND	0.001
RISD15	ND	ND	ND	ND	0.002	0.003
RISD16	ND	ND	ND	0.051	0.031	0.041
RISD17	ND	ND	ND	ND	0.002	ND
RISD18	1.93	7.15	0.03	0.041	0.075	0.027
RISD19	ND	ND	ND	ND	0.002	0.003
RISD20	ND	ND	ND	0.552	0.142	0.195
RISD21	ND	ND	ND	0.084	0.053	0.085

Sample ID	Benzo(b) fluoranthene (µg/g)	Benzo(g,h,i) perylene (µg/g)	Benzo(k) fluoranthene (µg/g)	Chrysene (µg/g)	DDD (µg/g)	DDE (µg/g)
RBC*	0.88	230 <sup>b</sup>	8.8	88	2.7	1.9
RISD14	0.003	ND	0.0009	ND	ND	ND
RISD15	0.006	ND	0.002	ND	ND	ND
RISD16	0.055	0.059	0.024	ND	ND	ND
RISD17	0.004	ND	0.002	ND	ND	ND
RISD18	0.094	0.119	0.046	0.035	ND	ND
RISD19	0.004	ND	0.002	ND	0.017	0.009
RISD20	0.141	0.102	0.082	ND	ND	ND
RISD21	0.106	0.067	0.044	ND	ND	ND

**Table 7-10 (Continued)**  
**Organics Detected In Sediment Samples Collected In AREE 1**

Sample ID	DDT (µg/g)	Dibenzo(a,h) anthracene (µg/g)	Fluoranthene (µg/g)	Indeno(1,2,3- cd)pyrene (µg/g)	PCB-1260 (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)
RBC <sup>a</sup>	1.9	0.088	310	0.88	0.083 <sup>c</sup>	230 <sup>b</sup>	230
RISD14	ND	ND	0.002	ND	ND	ND	ND
RISD15	ND	ND	0.004	ND	ND	ND	0.01
RISD16	ND	0.015	0.061	0.027	ND	ND	0.062
RISD17	ND	ND	0.005	ND	ND	ND	ND
RISD18	ND	0.012	0.131	0.056	ND	0.045	0.059
RISD19	0.018	ND	0.004	ND	ND	ND	0.009
RISD20	ND	ND	0.259	0.094	0.084	ND	0.419
RISD21	ND	ND	0.14	0.046	ND	ND	0.28

ND Not detected.

<sup>a</sup> Sediment RBC values are from USEPA Region III Residential Soil RBCs. RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

<sup>b</sup> The RBC for pyrene was used as a surrogate for non-carcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>c</sup> Value is for carcinogenic PCBs.

**Table 7-10 (Continued)**  
**Inorganics Detected in Surface Water Samples Collected in AREE 1**

SampleID	Aluminum (µg/L)	Barium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)
Site Background <sup>a</sup>	1,930	41.8	22,200	10.8	ND	2,510
RISW14	1,040	31.8	15,500	ND	ND	1,460
RISW15	953	31.7	15,500	ND	ND	1,400
RISW16	1,100	30.9	15,100	11.1	ND	1,420
RISW17	1,040	31.3	15,400	ND	ND	1,380
RISW18	927	31.5	15,500	ND	ND	1,310
RISW19	5,070	69.9	20,200	ND	17.6	6,900
RISW20	1,620	43	18,700	ND	ND	2,480
RISW21	3,170	55.2	18,900	ND	6.9	4,510

Sample ID	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Potassium (µg/L)	Sodium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
Site Background <sup>a</sup>	1.9	7,600	303	3,670	16,600	ND	ND
RISW14	1.5	5,050	238	3,400	11,800	ND	29.9
RISW15	1.5	5,050	148	3,670	11,300	ND	24.1
RISW16	1.6	4,930	159	3,720	11,100	ND	22.2
RISW17	1.4	5,050	204	3,460	11,500	ND	20.9
RISW18	1.5	5,020	136	3,780	11,400	ND	20.6
RISW19	8.4	6,970	373	5,070	14,700	13.1	40.1
RISW20	3.5	6,120	103	4,110	14,400	ND	25.8
RISW21	5.3	6,340	210	4,360	13,500	ND	29.2

ND Not detected.

<sup>a</sup> Site background concentrations are from samples RISWBK1 through RISWBK5.



**Table 7-10 (Continued)**  
**Inorganics Detected In Surface Water Runoff Samples Collected In AREE 1**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)
SWR01	6,480	2.2	49.8	ND	58,300	10.0
SWR01DUP	8,880	1.3	47.8	ND	33,300	11.4
SWR02	34,600	4.4	122	0.2	27,700	43.8
SWR03	43,300	5.6	139	0.3	21,800	53.0
SWR04	35,700	3.4	171	0.3	15,300	60.9

Sample ID	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Mercury (µg/L)	Nickel (µg/L)
SWR01	ND	9,980	5.5	10,600	555	ND	ND
SWR01DUP	5.5	12,600	8.7	6,600	207	ND	ND
SWR02	28.0	45,200	70.2	8,400	344	0.23	25.8
SWR03	28.4	48,500	47.2	9,460	603	0.23	22.6
SWR04	33.3	57,800	42.5	8,860	498	ND	29.0

Sample ID	Potassium (µg/L)	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
SWR01	2,660	7,740	ND	16.4	34.0
SWR01DUP	2,300	5,430	0.2	25	45.6
SWR02	6,880	5,680	0.3	87.4	164
SWR03	8,500	5,930	0.4	92.8	177
SWR04	7,950	3,260	0.3	106	197

ND      Not detected.

**Table 7-10 (Continued)**  
**Organics Detected In Surface Water Runoff Samples Collected in AREE 1**

Sample ID	Anthracene (µg/L)	Benzo(a)pyrene (µg/L)	Benzoic Acid (µg/L)	Fluoranthene (µg/L)	PCB-1260 (µg/L)	Pyrene (µg/L)
SWR01	ND	ND	5.2	ND	ND	ND
SWR02	1.35	0.014	ND	0.053	0.486	0.129
SWR03	2.73	0.016	ND	0.050	4.40	0.237
SWR04	0.923	ND	ND	ND	0.224	0.151

ND      Not detected.

**Table 7-10 (Continued)**  
**Compounds Detected in Site Wide Fish Tissue Samples in AREE 1**

Sample ID	Location	Alpha Chlordane (µg/g)	DDD (µg/g)	DDE (µg/g)	Gamma Chlordane (µg/g)
<b>RBC</b>		<b>0.0024</b>	<b>0.013</b>	<b>0.0093</b>	<b>0.0024</b>
S.FISH-1W	Marumsco	ND	ND	15.9	ND
S.FISH-2W	Marumsco	ND	ND	14.5	ND
S.FISH-3W	Marumsco	ND	ND	14	ND
S.FISH-4W	Marumsco	ND	ND	30.2	ND
S.FISH-5W	Marumsco	ND	ND	ND	ND
WPERCH-1W	Marumsco	14.7	ND	34.9	ND
WPERCH-2W	Marumsco	13.2	30.9	30.9	ND
WPERCH-3W	Marumsco	12.3	ND	28.6	ND
WPERCH-4W	Marumsco	16.3	ND	38.3	ND
WPERCH-5W	Marumsco	12	ND	29.1	ND

Sample ID	Location	Heptachlor (µg/g)	Mercury (µg/g)	PCB-1260 (µg/g)
<b>RBC<sup>a</sup></b>		<b>0.007</b>	<b>0.41</b>	<b>0.00041</b>
S.FISH-1W	Marumsco	ND	ND	126
S.FISH-2W	Marumsco	1.42	ND	105
S.FISH-3W	Marumsco	ND	ND	97.6
S.FISH-4W	Marumsco	ND	ND	110
S.FISH-5W	Marumsco	ND	ND	115
WPERCH-1W	Marumsco	ND	0.05	267
WPERCH-2W	Marumsco	ND	0.026	227
WPERCH-3W	Marumsco	ND	0.025	234
WPERCH-4W	Marumsco	ND	0.039	277
WPERCH-5W	Marumsco	ND	0.029	221

ND Not Detected.

<sup>a</sup> The maximum detected concentrations of organic and inorganic compounds were compared to USEPA Region III residential RBCs, in accordance with Region III guidance (USEPA, 1996a). The RBCs are health-protective chemical concentrations that are back-calculated using toxicity criteria, a  $1 \times 10^{-6}$  target risk level or a 0.1 hazard index, and conservative exposure parameters.

**Table 7-11**  
**Summary of RI Results for AREEs 2 and 5 - Former Dump Nos. 2 and 5**  
**(greater than 2 feet bgs)**

Media Sampled <sup>a</sup>	Number of Samples Collected	Compounds/Analytes Detected above LOC <sup>b</sup>	Summary of Fate & Transport
Surface Soil	5	Al, Ba, Be, Cu, Pb, Mn, K, Na	Infiltration/percolation through soil to groundwater
Subsurface Soil (0- to 2-feet bgs)	7	Al, As, Ba, Be, Ca, Cr, Co, Pb, Mn, Hg, K, Se, V	
Subsurface Soil (2-ft bgs to Water Table)	19	Sb, Ca, Mn, K, Ag, V PCB-1248, PCB-1254	
Test Pits	4	Al, Ba, Be, Ca, Cr, Co, Cu, Fe, Pb, Mn, K, Na, Zn	
Groundwater	Round 1 - 15 Round 2 - 9	Cr, Fe, Pb, Mg, Mn, Ni, Se, Ti, Zn  Aldrin, gamma-BHC, heptachlor epoxide	Discharge to surface water
Sediment	3	Na, V	Stormwater runoff to surface water/sediment
Surface Water	3	Al, Ba, Cu, Fe, Pb, K, V	Stormwater runoff to surface water/sediment
Surface Water Runoff	3	Anthracene, DDE, DDT, Fluoranthene, Pyrene	Stormwater runoff to surface water/sediment

<sup>a</sup> Surface soil and groundwater samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH. Subsurface soil and test pit samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH.

<sup>b</sup> LOC - Level of Concern. Refers to either the WRF site background maximum concentrations for inorganics or Region III residential risk-based concentrations (RBCs) for organics.

**Table 7-11 (Continued)**  
**Inorganics Detected in Surface Soil Samples Collected in AREEs 2 and 5**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)
Site Background <sup>a</sup>	14,350	92.4	0.814	1,150	31.3	18.6
RISS5	13,100	55.6	0.874	312	20.6	6.96
RISS6	6,480	ND	0.451	346	7.58	ND
RISS7	15,200	80.2	1.02	517	17.8	11.4
RISS8	7,990	67.2	0.609	631	11.5	5.33
RISS9	9,810	117	1.33	1,080	13.4	16.3

Sample ID	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)
Site Background <sup>a</sup>	12.6	28,100	22.4	2,610	875	11.9
RISS5	4.41	13,700	17.2	1,320	207	8.33
RISS6	4.73	7,790	21.3	523	45.6	4.18
RISS7	13.3	19,800	22.1	1,260	116	9.22
RISS8	7.79	11,000	24.8	658	195	6.53
RISS9	9.52	10,900	13.0	1,140	1,450	10.4

Sample ID	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	936	487	58.9	43.9
RISS5	608	465	35.2	29.8
RISS6	495	457	22.3	18.8
RISS7	1,130	551	45.3	43.1
RISS8	647	425	32.7	31.0
RISS9	751	497	21.0	37.7

<sup>a</sup> Site background concentrations are based on WRF maximum background concentrations in surface soil samples MW-52 through MW-54 and RIBKSS1 through RIBKSS5.

ND Not detected.

**Table 7-11 (Continued)**  
**Organics Detected in Surface Soil Samples Collected in AREEs 2 and 5**

Sample ID	Acenaphthene (µg/g)	Anthracene (µg/g)	Benzo(a)anthracene (µg/g)	Benzo(a)pyrene (µg/g)	Benzo(b)fluoranthene (µg/g)	Benzo(g,h,i) perylene (µg/g)
RBC <sup>a</sup>	470	2,300	0.88	0.088	0.88	230 <sup>b</sup>
RISS5	ND	ND	ND	0.001	0.002	ND
RISS6	ND	0.040	0.004	0.006	0.011	0.011
RISS7	0.185	0.010	0.005	0.006	0.009	0.012
RISS8	ND	0.037	0.003	0.005	0.009	0.009
RISS9	ND	0.044	0.007	0.004	0.024	0.014

Sample ID	Benzo(k) fluoranthene (µg/g)	Bis(2-ethylhexyl)-phthalate (µg/g)	Chrysene (µg/g)	DDT (µg/g)	Fluoranthene (µg/g)	Indeno(1,2,3-cd)pyrene (µg/g)
RBC <sup>a</sup>	8.8	45	88	1.9	310	0.88
RISS5	0.001	0.870	ND	ND	0.004	ND
RISS6	0.005	ND	0.013	ND	0.022	0.009
RISS7	0.005	ND	ND	ND	0.018	0.008
RISS8	0.004	ND	ND	ND	0.012	0.007
RISS9	0.009	ND	0.022	0.009	0.025	0.009

Sample ID	Naphthalene (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)
RBC <sup>a</sup>	310	230 <sup>b</sup>	230
RISS5	ND	0.060	ND
RISS6	1.27	0.474	ND
RISS7	4.97	0.187	ND
RISS8	ND	1.39	ND
RISS9	ND	ND	0.051

ND

Not detected.

<sup>a</sup>

The maximum detected concentrations of organic and inorganic compounds were compared to USEPA Region III residential RBCs, in accordance with Region III guidance (USEPA, 1996a). The RBCs are health-protective chemical concentrations that are back-calculated using toxicity criteria, a  $1 \times 10^{-6}$  target risk level or a 0.1 hazard index, conservative exposure parameters.

<sup>b</sup>

The RBC for pyrene was used as a surrogate for non-carcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

**Table 7-11 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (0 to 2 ft bgs) Collected in AREEs 2 and 5**

Sample ID	Aluminum (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background <sup>a</sup>	14,350	3.80	92.4	0.814	1,150	31.3
MW-68	13,400	ND	71.6	0.99	285	23.3
MW-70	21,100	ND	62.1	0.80	182	29.5
MW-71	9,430	ND	ND	0.64	522	30.6
MW-71DUP	9,940	ND	62.4	1.26	575	15.1
MW-74	10,500	ND	43.9	0.46	227	14.1
MW-81	8,980	ND	77.4	0.56	4,170	17.8
RISB6	9,660	ND	ND	0.69	209	12.7

Sample ID	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Mercury (µg/g)
Site Background <sup>a</sup>	16.6	12.6	28,100	22.4	2,610	875	ND
MW-68	20.0	7.46	26,700	14.6	1,300	858	ND
MW-70	10.2	11.4	25,300	11.1	2,100	148	ND
MW-71	8.77	14.0	16,400	ND	1,830	247	ND
MW-71DUP	37.5	8.08	17,900	11.5	1,310	684	ND
MW-74	4.24	6.74	11,400	23.6	775	48.2	ND
MW-81	12.8	8.35	13,500	22.4	891	1,100	ND
RISB6	4.25	9.72	14,600	24.3	693	57.7	ND

Sample ID	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	11.9	936	14.2	487	58.9	43.9
MW-68	6.52	412	15.3	429	50.3	26.0
MW-70	11.8	665	ND	365	54.8	41.9
MW-71	11.6	503	ND	585	37.6	34.5
MW-71DUP	6.37	589	ND	494	31.5	23.0
MW-74	5.40	569	ND	441	25.0	25.4
MW-81	8.62	478	ND	320	28.8	32.3
RISB6	4.95	519	ND	489	29.6	32.6

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for subsurface soil samples.

**Table 7-11 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table)**  
**Collected in AREEs 2 and 5**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Antimony (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background*		18,200	ND	73.8	1.02	454	25.0
MW-68	10	6,610	ND	ND	0.40	266	10.5
	20	1,850	ND	ND	0.40	392	4.50
MW-70	5	11,100	ND	ND	0.44	ND	18.8
	10	4,020	ND	ND	ND	ND	6.19
MW-71	5	14,700	0.40	ND	0.84	265	18.6
	10	4,580	ND	68.9	0.72	1,260	8.22
MW-72	5	10,100	ND	ND	0.30	154	16.6
	10	5,650	ND	ND	ND	637	7.56
	15	815	ND	ND	ND	128	1.68
MW-73	5	9,360	ND	ND	0.43	479	15.9
	10	4,830	ND	54.8	0.80	871	7.46
	15	6,880	ND	ND	0.38	634	13.3
MW-74	5	7,780	ND	ND	0.38	ND	15.4
	15	2,610	ND	ND	0.36	370	4.53
MW-74DUP	15	4,760	ND	ND	0.37	531	5.14
MW-81	5	12,100	ND	47.7	0.44	7,520	20.1
	10	11,400	ND	64.4	0.81	2,700	19.2
RISB6	5	7,640	ND	54.9	0.47	298	13.9
	15	7,480	ND	73	0.53	934	6.55



**Table 7-11 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table)**  
**Collected in AREEs 2 and 5**

Sample ID	Depth bgs (ft)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background*		13.9	16.9	27,800	11.8	3,700	617
MW-68	10	3.39	6.26	10,900	ND	1,410	62.8
	20	ND	5.41	17,900	ND	281	53.3
MW-70	5	4.84	8.08	12,300	ND	2,090	56.0
	10	4.91	2.67	4,480	ND	519	131
MW-71	5	9.71	11.40	19,100	ND	1,730	412
	10	ND	13.20	3,240	ND	884	10.9
MW-72	5	2.58	8.96	7,630	ND	1,660	49.7
	10	ND	6.05	5,110	ND	712	9.40
	15	ND	1.36	3,330	ND	121	18.7
MW-73	5	3.29	7.92	10,100	10.2	1,200	69.9
	10	3.68	8.75	8,550	ND	823	8.54
	15	ND	7.01	17,800	ND	854	57.0
MW-74	5	2.44	9.21	4,370	9.02	943	23.0
	15	ND	3.87	5,040	ND	415	12.8
MW-74DUP	15	3.01	4.33	3,440	ND	665	25.6
MW-81	5	6.08	10	14,000	ND	2,690	151
	10	11	9.15	17,100	17	1,180	622
RISB6	5	4.37	9.38	6,560	10.6	821	19.5
	15	6.43	12.7	6,770	ND	1,260	98.2

**Table 7-11 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table)**  
**Collected in AREEs 2 and 5**

Sample ID	Depth bgs (ft)	Nickel (µg/g)	Potassium (µg/g)	Silver (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>		17.9	624	ND	933	25.8	46.3
MW-68	10	4.57	278	ND	345	26.1	16.4
	20	ND	188	ND	346	7.30	ND
MW-70	5	6.17	359	2.08	383	36.8	21.3
	10	ND	163	ND	249	10.5	6.71
MW-71	5	8.52	576	ND	484	37.5	26.7
	10	4.34	336	ND	407	18.5	13.0
MW-72	5	8.12	343	ND	357	27.9	27.2
	10	3.09	182	ND	350	11.6	8.70
	15	ND	ND	ND	244	5.88	ND
MW-73	5	5.50	381	ND	413	34.0	27.1
	10	5.72	216	ND	456	16.9	26.4
	15	4.10	460	ND	541	24.2	23.7
MW-74	5	4.20	264	ND	344	17.8	14.6
	15	2.80	164	ND	432	10.8	8.70
MW-74DUP	15	3.79	428	ND	472	13.0	17
MW-81	5	8.15	460	ND	431	35.8	24.6
	10	8.25	778	ND	332	32.6	37.7
RISB6	5	4.39	430	ND	557	26.9	16.4
	15	5.64	567	ND	535	14.2	24.1

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for subsurface soil samples.

**Table 7-11 (Continued)**  
**Organics Detected in Subsurface Soil Samples (0 to 2 ft bgs) Collected in AREEs 2 and 5**

Sample ID	Bis(2-ethylhexyl)-phthalate (µg/g)	DDT (µg/g)	Di-n-butylphthalate (µg/g)	Endosulfan Sulfate (µg/g)	Methoxychlor (µg/g)
RBC <sup>a</sup>	46	1.9	780	47 <sup>c</sup>	39
MW-68	ND	ND	ND	ND	ND
MW-70	0.63	ND	4.10	ND	ND
MW-71	0.24	0.01	ND	ND	ND
MW-71DUP	0.38	ND	ND	ND	ND
MW-74	ND	ND	ND	ND	ND
MW-81	ND	ND	ND	ND	ND
RISB6	0.21	ND	ND	ND	ND

Sample ID	PCB-1248 (µg/g)	PCB-1254 (µg/g)	TPH, as Diesel (µg/g)	TPH, as Gas (µg/g)
RBC <sup>a</sup>	0.083 <sup>b</sup>	0.16	---	---
MW-68	ND	ND	ND	ND
MW-70	ND	ND	ND	ND
MW-71	ND	ND	ND	ND
MW-71DUP	ND	ND	ND	ND
MW-74	ND	ND	27.9	9.88
MW-81	0.22	1.00	ND	ND
RISB6	ND	ND	ND	ND

ND Not detected

<sup>a</sup> The soil RBC values are from the USEPA Region III Residential RBCs (USEPA, 1996a). RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

<sup>b</sup> Value is for carcinogenic PCBs.

<sup>c</sup> RBC for endosulfan was used.

**Table 7-11 (Continued)**  
**Organics Detected in Subsurface Soil Samples (2 ft bgs to Water Table)**  
**Collected in AREEs 2 and 5**

Sample ID	Depth bgs (ft)	Acetone (µg/g)	Benzoic Acid (µg/g)	Bis(2-ethyl-hexyl) phthalate (µg/g)	Di-n-butyl Phthalate (µg/g)	Endosulfan Sulfate (µg/g)	Methylene Chloride (µg/g)	PCB-1248 (µg/g)	PCB-1254 (µg/g)
RBC <sup>a</sup>		780	31,000	46	780	47 <sup>b</sup>	85	0.083 <sup>c</sup>	0.15
MW-68	10	ND	ND	0.40	ND		ND	ND	ND
	20	0.01	ND	ND	ND	ND	ND	ND	ND
MW-70	5	ND	ND	0.54	3.90	ND	ND	ND	ND
	10	0.01	ND	0.49	3.60	ND	ND	ND	ND
MW-71	5	ND	ND	0.19	ND	ND	ND	ND	ND
	10	ND	ND	ND	ND	ND	ND	ND	ND
MW-72	5	ND	ND	0.81	3.70	ND	ND	ND	ND
	10	ND	ND	1.10	4.30	ND	ND	ND	ND
	15	0.02	ND	1.00	3.50	ND	0.01	ND	ND
MW-73	5	ND	ND	0.21	ND	ND	ND	ND	ND
	10	ND	ND	0.22	ND	ND	ND	ND	ND
	15	ND	ND	0.74	ND	ND	ND	ND	ND
MW-74	5	ND	ND	ND	ND	ND	ND	ND	ND
	15	ND	ND	ND	ND	ND	ND	ND	ND
MW-74	15	ND	0.68	ND	ND	ND	ND	ND	ND
MW-81	5	0.02	ND	ND	ND	ND	ND	ND	ND
	10	ND	ND	ND	ND	ND	ND	0.36	0.16
RISB6	5	ND	ND	0.23	ND	ND	ND	ND	ND
	15	ND	ND	0.23	ND	ND	ND	ND	ND

ND Not detected.

<sup>a</sup> The maximum detected concentrations of organic and inorganic compounds were compared to USEPA Region III residential RBCs, in accordance with Region III guidance (USEPA, 1996a). The RBCs are health-protective chemical concentrations that are back-calculated using toxicity criteria, a  $1 \times 10^{-6}$  target risk level or a 0.1 hazard index, and conservative exposure parameters.

<sup>b</sup> The RBC for endosulfan was used.

<sup>c</sup> Value is for carcinogenic PCBs.

-- No value available.

**Table 7-11 (Continued)**  
**Inorganics Detected in Test Pit Samples Collected in AREEs 2 and 5**  
**(greater than 2 feet bgs)**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background*		18,200	73.2	1.02	454	25.0
TP-3A	9.4	15,000	ND	0.963	200	14.2
TP-3B	7	20,700	53.3	0.609	436	26.1
TP-4A	6	15,800	375	2.44	8,820	24.4
TP-4B	4	9,480	66.6	1.08	535	22.8

Sample ID	Depth bgs (ft)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)
Site Background*		13.9	16.9	27,800	11.8	3,700
TP-3A	9.4	6.82	6.36	14,300	ND	1,150
TP-3B	7	6.79	10.4	16,700	12.5	2,340
TP-4A	6	23.2	47.0	40,400	113	1,960
TP-4B	4	7.40	13.0	18,000	18.9	1,250

Sample ID	Depth bgs (ft)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background*		617	17.9	624	933	25.8	46.3
TP-3A	9.4	134	7.59	583	413	27.7	30.3
TP-3B	7	143	9.04	846	465	46.1	42.5
TP-4A	6	3,270	16.8	1,230	1,190	44.3	416
TP-4B	4	211	9.41	892	453	49.4	66.2

ND Not detected.

\* Site background concentrations are based on WRF maximum background concentrations for samples MW-52 through MW-54, each at two depths.

**Table 7-11 (Continued)**  
**Organics Detected in Test Pit Samples Collected in AREES 2 and 5**

Sample ID	Depth fgs (ft)	Methylene Chloride (µg/g)
RBC <sup>a</sup>		85
TP-3A	9.4	ND
TP-3B	7	0.010
TP-4A	6	0.03
TP-4B	4	0.01

ND Not detected.

<sup>a</sup> USEPA Region III residential risk-based concentration (RBC) values.

**Table 7-11 (Continued)**  
**Inorganics Detected in Groundwater Samples Collected in AREEs 2 and 5**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)
Site Background <sup>1</sup>	12,500	6.70	107	0.8	42,200	22.3
MW-1	130	ND	ND	ND	790	ND
MW-2	63.2	ND	38.4	ND	10,600	ND
MW-3	ND	ND	30.1	ND	16,900	ND
MW-4	5,950	ND	52.9	0.1	2,470	23.5
MW-5	150	1.7	58.5	0.1	8,050	ND
MW-68	101	ND	ND	0.2	1,120	ND
MW-68 Round 2	132	ND	ND	ND	888	ND
MW-70	156	ND	32.8	ND	2,530	ND
MW-70 Round 2	263	ND	ND	ND	1,620	ND
MW-71	ND	ND	31.3	ND	2,530	ND
MW-71 Round 2	161	ND	31.9	ND	2,460	ND
MW-71DUP	ND	ND	30.1	ND	2,460	ND
MW-72	51.6	ND	33.1	ND	2,640	ND
MW-72 Round 2	174	ND	25.0	ND	1,680	ND
MW-73	72.8	ND	31.1	ND	2,850	ND
MW-73 Round 2	232	ND	29.9	ND	3,480	ND
MW-74	ND	ND	52.4	ND	5,180	ND
MW-74 Round 2	188	ND	ND	ND	942	ND
MW-81	416	ND	51.3	ND	20,700	ND
MW-81 Round 2	284	1.7	58.3	ND	26,600	ND
MW-82	242	ND	86.3	ND	12,300	ND
MW-82 Round 2	165	ND	80.3	ND	11,900	ND
MW-83	494	ND	ND	ND	2,690	ND
MW-83 Round 2	1,910	ND	ND	ND	1,590	ND

**Table 7-11 (Continued)**  
**Inorganics Detected in Groundwater Samples Collected in AREEs 2 and 5**

Sample ID	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)
Site Background*	8.9	9,620	6.3	7,720	354	18.4
MW-1	ND	127	15.9	706	ND	ND
MW-2	ND	45.9	ND	5,700	388	ND
MW-3	ND	829	ND	5,880	203	ND
MW-4	8.3	4,290	25.7	2,470	104	28.1
MW-5	ND	14,600	15.5	4,640	74.5	ND
MW-68	ND	75.8	ND	837	32.1	ND
MW-68 Round 2	ND	98.3	3.3	677	14.4	ND
MW-70	ND	157	ND	2,890	153	ND
MW-70 Round 2	ND	188	1.2	2,230	95.6	ND
MW-71	ND	ND	ND	2,160	46.3	ND
MW-71 Round 2	ND	126	2.9	2,390	45.5	ND
MW-71DUP	ND	ND	ND	2,140	44.5	ND
MW-72	ND	144	6.6	1,790	70.1	ND
MW-72 Round 2	ND	136	1.9	1,580	34.6	ND
MW-73	ND	1,310	ND	1,380	80.1	ND
MW-73 Round 2	ND	558	1.6	1,570	64.2	ND
MW-74	ND	3,290	ND	2,650	115	ND
MW-74 Round 2	ND	309	1.4	559	40.4	ND
MW-81	ND	2,720	ND	3,960	353	ND
MW-81 Round 2	ND	2,990	ND	3,730	324	18.8
MW-82	ND	12,500	ND	6,440	547	ND
MW-82 Round 2	ND	9,520	ND	5,890	491	ND
MW-83	ND	3,750	ND	845	225	ND
MW-83 Round 2	5.7	4,470	1.4	801	275	ND



**Table 7-11 (Continued)**  
**Inorganics Detected in Groundwater Samples Collected in AREEs 2 and 5**

Sample ID	Potassium (µg/L)	Selenium (µg/L)	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
Site Background <sup>a</sup>	20,600	4.2	43,500	0.1	29.8	48
MW-1	ND	ND	8,530	ND	ND	51
MW-2	1,100	ND	3,390	ND	ND	ND
MW-3	1,310	ND	4,640	ND	ND	ND
MW-4	1,260	ND	5,610	0.1	10.7	85.4
MW-5	1,890	ND	26,400	ND	ND	ND
MW-68	ND	ND	8,710	ND	ND	ND
MW-68 Round 2	607	ND	9,120	ND	ND	26.3
MW-70	ND	2.5	17,600	ND	ND	23.9
MW-70 Round 2	588	ND	9,680	ND	ND	40.0
MW-71	714	ND	5,350	ND	ND	ND
MW-71 Round 2	971	ND	4,730	ND	ND	ND
MW-71DUP	648	ND	5,170	ND	ND	ND
MW-72	ND	ND	7,380	ND	ND	24.4
MW-72 Round 2	614	ND	5,710	ND	ND	33.6
MW-73	1,040	ND	5,550	ND	ND	21.7
MW-73 Round 2	1,530	ND	5,440	ND	ND	ND
MW-74	868	3.1	25,600	ND	ND	25.9
MW-74 Round 2	966	ND	18,200	ND	ND	ND
MW-81	3,740	2.5	5,910	ND	ND	ND
MW-81 Round 2	7,520	2.6	6,580	ND	ND	ND
MW-82	3,230	ND	34,300	ND	ND	ND
MW-82 Round 2	2,890	2.5	27,700	ND	ND	22.8
MW-83	1,290	ND	3,360	ND	ND	ND
MW-83 Round 2	1,430	ND	3,230	ND	ND	ND

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF maximum background concentrations for groundwater.

<sup>b</sup> Round 2 sampling was conducted in March 1996.

**Table 7-11 (Continued)**  
**Organics Detected in Groundwater Samples Collected in AREEs 2 and 5**

Sample ID	1-Methyl naphthalene (µg/L)	4-Methyl Phenol (µg/L)	Acenaphthylene (µg/L)	Aldrin (µg/L)	Anthracene (µg/L)	Benzoic Acid (µg/L)	Alpha BHC (µg/L)
RBC*	110	18	110	0.004	1,100	15,000	—
MW-1	ND	ND	ND	ND	ND	ND	ND
MW-2	ND	ND	ND	ND	ND	ND	ND
MW-3	ND	ND	ND	ND	ND	ND	ND
MW-4	ND	ND	ND	ND	ND	ND	ND
MW-5	ND	ND	ND	ND	ND	ND	ND
MW-68	ND	ND	ND	ND	ND	ND	ND
MW-68 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-70	ND	ND	ND	ND	0.177	ND	ND
MW-70 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-71	ND	ND	ND	ND	ND	ND	ND
MW-71 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-71 DUP	ND	ND	ND	ND	ND	ND	0.006
MW-72	ND	ND	ND	ND	ND	ND	ND
MW-72 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-73	ND	ND	ND	ND	0.203	ND	ND
MW-73 Round 2	ND	ND	ND	ND	ND	ND	0.008
MW-74	ND	ND	ND	ND	ND	ND	ND
MW-74 Round 2	ND	ND	ND	0.010	ND	ND	0.008
MW-81	ND	3.6	ND	ND	2.91	7.3	ND
MW-81 Round 2	ND	11	ND	ND	ND	25	0.008
MW-82	3.38	ND	6.49	0.009	1.32	ND	ND
MW-82 Round 2	ND	ND	ND	ND	ND	ND	0.033
MW-83	ND	ND	ND	ND	ND	ND	ND
MW-83 Round 2	ND	ND	ND	ND	ND	ND	0.008

**Table 7-11 (Continued)**  
**Organics Detected in Groundwater Samples Collected in AREEs 2 and 5**

Sample ID	Gamma-BHC (Lindane) (µg/L)	Bis(2-ethyl hexyl) Phthalate (µg/L)	DDT (µg/L)	Dimethyl Phthalate (µg/L)	Endosulfan Sulfate (µg/L)	Endosulfan II (µg/L)	Endrin (µg/L)
RBC*	0.052	4.8	0.2	37,000	22	—	1.1
MW-1	ND	ND	ND	ND	ND	ND	ND
MW-2	ND	ND	ND	ND	ND	ND	ND
MW-3	ND	ND	ND	ND	ND	ND	ND
MW-4	ND	45	ND	ND	ND	ND	ND
MW-5	ND	6	ND	ND	ND	ND	ND
MW-68	ND	5.2	ND	ND	ND	ND	ND
MW-68 Round 2	0.007	3.5	ND	ND	ND	ND	ND
MW-70	ND	2.3	ND	ND	ND	ND	ND
MW-70 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-71	ND	46	ND	ND	ND	ND	ND
MW-71 Round 2	ND	4.9	ND	ND	ND	ND	ND
MW-71DUP	ND	19	ND	ND	ND	ND	ND
MW-72	ND	2.6	ND	ND	ND	ND	ND
MW-72 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-73	ND	2	ND	ND	0.016	ND	ND
MW-73 Round 2	ND	ND	ND	ND	0.016	ND	ND
MW-74	ND	6.6	ND	ND	ND	ND	ND
MW-74 Round 2	ND	ND	ND	ND	ND	ND	0.012
MW-81	ND	29	ND	ND	ND	ND	ND
MW-81 Round 2	ND	2.5	ND	ND	ND	ND	ND
MW-82	0.214	13	0.051	5.3	0.033	0.031	0.022
MW-82 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-83	ND	13	ND	ND	ND	ND	ND
MW-83 Round 2	ND	2.1	ND	ND	ND	ND	ND

**Table 7-11 (Continued)**  
**Organics Detected in Groundwater Samples Collected in AREEs 2 and 5**

Sample ID	Fluoranthene (µg/L)	Gamma Chlordane (µg/L)	Heptachlor Epoxide (µg/L)	Methoxychlor (µg/L)	Phenanthrene (µg/L)	Phenol (µg/L)	Pyrene (µg/L)
RBC <sup>a</sup>	150	0.052	0.0012	18	110 <sup>b</sup>	2,200	110
MW-1	ND	ND	ND	ND	ND	ND	ND
MW-2	ND	ND	ND	ND	ND	ND	ND
MW-3	ND	ND	ND	ND	ND	ND	ND
MW-4	ND	ND	ND	ND	ND	ND	ND
MW-5	ND	ND	ND	ND	ND	ND	ND
MW-68	ND	ND	ND	ND	ND	ND	ND
MW-68 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-70	ND	ND	ND	ND	ND	ND	ND
MW-70 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-71	ND	ND	ND	ND	ND	ND	ND
MW-71 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-71DUP	ND	ND	ND	ND	ND	ND	ND
MW-72	ND	ND	ND	ND	ND	ND	ND
MW-72 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-73	0.023	ND	ND	ND	ND	ND	ND
MW-73 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-74	ND	ND	ND	ND	ND	ND	ND
MW-74 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-81	0.041	ND	ND	ND	2.77	5.9	ND
MW-81 Round 2	ND	ND	ND	ND	ND	14	ND
MW-82	0.052	0.012	0.035	ND	4.03	ND	0.551
MW-82 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-83	ND	ND	ND	0.012	ND	ND	ND
MW-83 Round 2	ND	ND	ND	ND	ND	ND	ND

ND Not detected.  
<sup>a</sup> Groundwater RBC values are from USEPA Region III Tap Water RBCs. RBCs for noncarcinogenic chemicals are based on hazard quotient of 0.1, following USEPA Region III guidance.  
<sup>b</sup> The RBC for pyrene was used as a surrogate for non-carcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.  
 -- No value available.

**Table 7-11 (Continued)**  
**Inorganics Detected in Sediment Samples Collected from AREEs 2 and 5**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)
Site Background <sup>a</sup>	16,900	176	1.38	6,000	33.7	21.4	44.4	36,500
RISD11	13,700	ND	ND	3,060	21.4	10.2	20.7	24,500
RISD12	13,200	ND	1.38	4,440	21.2	13.1	29.2	20,400
RISD13	14,700	ND	1.26	4,380	28.8	20.1	35.6	26,200

Sample ID	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	42.2	3,740	1,690	30.3	2,120	1,710	54.1	168
RISD11	ND	2,140	284	15.4	1,060	2,650	47.6	85.5
RISD12	ND	2,460	287	19.1	969	2,450	60.9	100
RISD13	35.3	3,200	874	22.5	1,610	1,530	64.4	139

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for sediment samples.

**Table 7-11 (Continued)**  
**Organics Detected in Sediment Samples Collected from AREEs 2 and 5**

Sample ID	1-Methylnaphthalene (µg/g)	2-Methylnaphthalene (µg/g)	Acenaphthene (µg/g)	Acenaphthylene (µg/g)	Acetone (µg/g)	Alpha-chlordane (µg/g)	Anthracene (µg/g)	Benzo(a)anthracene (µg/g)	Benzo(a)pyrene (µg/g)	Benzo(b)fluoranthene (µg/g)
RBC <sup>a</sup>	230 <sup>b</sup>	230 <sup>b</sup>	470	230 <sup>b</sup>	780	0.49	2,300	0.88	0.088	0.88
RISD11	0.479	ND	0.867	ND	ND	ND	0.331	0.016	ND	ND
RISD12	2.41	ND	1.59	ND	ND	ND	0.979	0.026	0.198	0.132
RISD13	ND	ND	ND	ND	0.05	ND	0.102	0.024	0.036	0.07

Sample ID	Benzo(g,h,i)perylene (µg/g)	Benzo(k)fluoranthene (µg/g)	Benzoic Acid (µg/g)	Bis(2-ethylhexyl)phthalate (µg/g)	Chrysene (µg/g)	Chlordane (µg/g)	DDD (µg/g)	DDE (µg/g)	Dibenzo(a,h)anthracene (µg/g)	Diethyl phthalate (µg/g)
RBC <sup>a</sup>	230 <sup>b</sup>	8.8	31,000	46	88	0.49	2.7	1.9	0.088	6,300
RISD11	0.162	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD12	ND	0.07	ND	ND	ND	ND	ND	ND	ND	ND
RISD13	ND	0.021	ND	ND	ND	ND	ND	ND	ND	ND

Sample ID	Fluoranthene (µg/g)	Fluorene (µg/g)	Gamma-chlordane (µg/g)	Indeno(1,2,3-cd)pyrene (µg/g)	Naphthalene (µg/g)	PCB-1260 (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)	TPH, as Diesel (µg/g)
RBC <sup>a</sup>	310	310	0.049	0.88	310	0.083 <sup>c</sup>	230 <sup>b</sup>	230	—
RISD11	0.045	ND	ND	ND	1.11	ND	ND	0.103	35.6
RISD12	0.095	ND	ND	0.66	1.88	ND	ND	0.081	57.8
RISD13	0.07	0.151	ND	0.069	ND	ND	ND	0.159	ND

ND Not detected.

<sup>a</sup> Sediment RBC values are from USEPA Region III Residential Soil RBCs. RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

<sup>b</sup> The RBC for pyrene was used as a surrogate for non-carcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>c</sup> Value is for carcinogenic PCBs.

— No value available.

**Table 7-11 (Continued)**  
**Inorganics Detected in Surface Water Samples Collected from AREEs 2 and 5**

Sample ID Site Background*	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)
	1,930	1.4	41.8	ND	22,200	10.8	ND	2,510	1.9
RISW11	1,800	ND	ND	ND	3,470	ND	ND	2,110	1.2
RISW12	2,100	ND	ND	ND	3,920	ND	ND	2,770	1.6
RISW13	3,460	ND	54.3	ND	183	ND	6.1	4,110	5.2

Sample ID Site Background*	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
	7,500	303	ND	3,670	ND	16,500	ND	ND	ND
RISW11	1,840	56.1	ND	2,650	ND	2,480	ND	ND	ND
RISW12	2,070	91.2	ND	2,910	ND	3,320	ND	ND	ND
RISW13	6,310	183	ND	4,490	ND	13,800	ND	10.8	ND

ND Not detected.

\* Site background concentrations are based on WRF site background maximum concentrations for surface water samples.

**Table 7-11 (Continued)**  
**Inorganics Detected In Surface Water Runoff Samples Collected In AREEs 2 and 5**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)
SWR010	2,570	1.2	86.3	0.1	7,020	ND
SWR011	30,200	2.9	178	0.6	6,880	40.9
SWR012	1,080	ND	72.1	ND	6,220	ND

Sample ID	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)
SWR010	ND	15,800	5.3	4,610	863	ND	1,250
SWR011	33.0	31,100	45.9	4,640	571	16.1	6,240
SWR012	ND	20,790	1.3	4,450	1,390	ND	1,920

Sample ID	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
SWR010	9,720	ND	12.2	27.2
SWR011	1,460	0.4	82.5	723
SWR012	5,640	ND	ND	86.0

ND Not detected.



**Table 7-11 (Continued)**  
**Organics Detected In Surface Water Runoff Samples Collected In AREEs 2 and 5**

Sample ID	Anthracene (µg/L)	DDE (µg/L)	DDT (µg/L)	Endosulfan Sulfate (µg/L)	Fluoranthene (µg/L)	Pyrene (µg/L)
SWR010	ND	ND	ND	0.105	0.023	ND
SWR011	0.161	0.012	0.018	ND	0.022	0.137
SWR012	ND	ND	ND	0.495	ND	ND

ND Not detected.

**Table 7-11**  
**Summary of RI Results for AREEs 2 and 5 - Former Dump Nos. 2 and 5**  
**(greater than 2 feet bgs)**

Media Sampled <sup>a</sup>	Number of Samples Collected	Compounds/Analytes Detected above LOC <sup>b</sup>	Summary of Fate & Transport
Surface Soil	5	Al, Ba, Be, Cu, Pb, Mn, K, Na	Infiltration/percolation through soil to groundwater
Subsurface Soil (0- to 2-feet bgs)	7	Al, As, Ba, Be, Ca, Cr, Co, Pb, Mn, Hg, K, Se, V	
Subsurface Soil (2-ft bgs to Water Table)	19	Sb, Ca, Mn, K, Ag, V PCB-1248, PCB-1254	
Test Pits	4	Al, Ba, Be, Ca, Cr, Co, Cu, Fe, Pb, Mn, K, Na, Zn	
Groundwater	Round 1 - 15 Round 2 - 9	Cr, Fe, Pb, Mg, Mn, Ni, Se, Ti, Zn  Aldrin, gamma-BHC, heptachlor epoxide	Discharge to surface water
Sediment	3	Na, V	Stormwater runoff to surface water/sediment
Surface Water	3	Al, Ba, Cu, Fe, Pb, K, V	Stormwater runoff to surface water/sediment
Surface Water Runoff	3	Anthracene, DDE, DDT, Fluoranthene, Pyrene	Stormwater runoff to surface water/sediment

<sup>a</sup> Surface soil and groundwater samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH. Subsurface soil and test pit samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH.

<sup>b</sup> LOC - Level of Concern. Refers to either the WRF site background maximum concentrations for inorganics or Region III residential risk-based concentrations (RBCs) for organics.

**Table 7-11 (Continued)**  
**Inorganics Detected in Surface Soil Samples Collected in AREEs 2 and 5**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)
Site Background <sup>a</sup>	14,350	92.4	0.814	1,150	31.3	18.6
RISS5	13,100	55.6	0.874	312	20.6	6.96
RISS6	6,480	ND	0.451	346	7.58	ND
RISS7	15,200	80.2	1.02	517	17.8	11.4
RISS8	7,990	67.2	0.609	631	11.5	5.33
RISS9	9,810	117	1.33	1,080	13.4	16.3

Sample ID	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)
Site Background <sup>a</sup>	12.6	28,100	22.4	2,610	876	11.9
RISS5	4.41	13,700	17.2	1,320	207	8.33
RISS6	4.73	7,790	21.3	523	45.6	4.18
RISS7	13.3	19,800	22.1	1,260	116	9.22
RISS8	7.79	11,000	24.8	658	195	6.53
RISS9	9.52	10,900	13.0	1,140	1,450	10.4

Sample ID	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	936	487	58.9	43.9
RISS5	608	465	35.2	29.8
RISS6	495	457	22.3	18.8
RISS7	1,130	551	45.3	43.1
RISS8	647	425	32.7	31.0
RISS9	751	497	21.0	37.7

<sup>a</sup> Site background concentrations are based on WRF maximum background concentrations in surface soil samples MW-52 through MW-54 and RIBKSS1 through RIBKSS5.

ND Not detected.

**Table 7-11 (Continued)**  
**Organics Detected in Surface Soil Samples Collected in AREEs 2 and 5**

Sample ID	Acenaphthene (µg/g)	Anthracene (µg/g)	Benzo(a)anthracene (µg/g)	Benzo(a)pyrene (µg/g)	Benzo(b)fluoranthene (µg/g)	Benzo(g,h,i)perylene (µg/g)
RBC <sup>a</sup>	470	2,300	0.88	0.088	0.88	230 <sup>b</sup>
RISS5	ND	ND	ND	0.001	0.002	ND
RISS6	ND	0.040	0.004	0.006	0.011	0.011
RISS7	0.185	0.010	0.005	0.006	0.009	0.012
RISS8	ND	0.037	0.003	0.005	0.009	0.009
RISS9	ND	0.044	0.007	0.004	0.024	0.014

Sample ID	Benzo(k)fluoranthene (µg/g)	Bis(2-ethylhexyl)-phthalate (µg/g)	Chrysene (µg/g)	DDT (µg/g)	Fluoranthene (µg/g)	Indeno(1,2,3-cd)pyrene (µg/g)
RBC <sup>a</sup>	8.8	46	88	1.9	310	0.88
RISS5	0.001	0.870	ND	ND	0.004	ND
RISS6	0.005	ND	0.013	ND	0.022	0.009
RISS7	0.005	ND	ND	ND	0.018	0.008
RISS8	0.004	ND	ND	ND	0.012	0.007
RISS9	0.009	ND	0.022	0.009	0.025	0.009

Sample ID	Naphthalene (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)
RBC <sup>a</sup>	310	230 <sup>b</sup>	230
RISS5	ND	0.060	ND
RISS6	1.27	0.474	ND
RISS7	4.97	0.187	ND
RISS8	ND	1.39	ND
RISS9	ND	ND	0.051

ND Not detected.

<sup>a</sup> The maximum detected concentrations of organic and inorganic compounds were compared to USEPA Region III residential RBCs, in accordance with Region III guidance (USEPA, 1996a). The RBCs are health-protective chemical concentrations that are back-calculated using toxicity criteria, a  $1 \times 10^{-6}$  target risk level or a 0.1 hazard index, conservative exposure parameters.

<sup>b</sup> The RBC for pyrene was used as a surrogate for non-carcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

**Table 7-11 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (0 to 2 ft bgs) Collected in AREEs 2 and 5**

Sample ID	Aluminum (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background <sup>a</sup>	14,350	3.80	92.4	0.814	1,150	31.3
MW-68	13,400	ND	71.6	0.99	285	23.3
MW-70	21,100	ND	62.1	0.80	182	29.5
MW-71	9,430	ND	ND	0.64	522	30.6
MW-71DUP	9,940	ND	62.4	1.26	575	15.1
MW-74	10,500	ND	43.9	0.46	227	14.1
MW-81	8,980	ND	77.4	0.56	4,170	17.8
RISB6	9,660	ND	ND	0.69	209	12.7

Sample ID	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Mercury (µg/g)
Site Background <sup>a</sup>	16.6	12.6	29,100	22.4	2,610	875	ND
MW-68	20.0	7.46	26,700	14.6	1,300	858	ND
MW-70	10.2	11.4	25,300	11.1	2,100	148	ND
MW-71	8.77	14.0	16,400	ND	1,830	247	ND
MW-71DUP	37.5	8.08	17,900	11.5	1,310	684	ND
MW-74	4.24	6.74	11,400	23.6	775	48.2	ND
MW-81	12.8	8.35	13,500	22.4	891	1,100	ND
RISB6	4.25	9.72	14,600	24.3	693	57.7	ND

Sample ID	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	11.9	936	14.2	487	58.9	43.9
MW-68	6.52	412	15.3	429	50.3	26.0
MW-70	11.8	665	ND	365	54.8	41.9
MW-71	11.6	503	ND	585	37.6	34.5
MW-71DUP	6.37	589	ND	494	31.5	23.0
MW-74	5.40	569	ND	441	25.0	25.4
MW-81	8.62	478	ND	320	28.8	32.3
RISB6	4.95	519	ND	489	29.6	32.6

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for subsurface soil samples.

**Table 7-11 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table)**  
**Collected in AREEs 2 and 5**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Antimony (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background*		18,200	ND	73.8	1.02	454	25.0
MW-68	10	6,610	ND	ND	0.40	266	10.5
	20	1,850	ND	ND	0.40	392	4.50
MW-70	5	11,100	ND	ND	0.44	ND	18.8
	10	4,020	ND	ND	ND	ND	6.19
MW-71	5	14,700	0.40	ND	0.84	265	18.6
	10	4,580	ND	68.9	0.72	1,260	8.22
MW-72	5	10,100	ND	ND	0.30	154	16.6
	10	5,650	ND	ND	ND	637	7.56
	15	815	ND	ND	ND	128	1.68
MW-73	5	9,360	ND	ND	0.43	479	15.9
	10	4,830	ND	54.8	0.80	871	7.46
	15	6,880	ND	ND	0.38	634	13.3
MW-74	5	7,780	ND	ND	0.38	ND	15.4
	15	2,610	ND	ND	0.36	370	4.53
MW-74DUP	15	4,760	ND	ND	0.37	531	5.14
MW-81	5	12,100	ND	47.7	0.44	7,520	20.1
	10	11,400	ND	64.4	0.81	2,700	19.2
RISB6	5	7,640	ND	54.9	0.47	298	13.9
	15	7,480	ND	73	0.53	934	6.55

**Table 7-11 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table)**  
**Collected in AREEs 2 and 5**

Sample ID	Depth bgs (ft)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background*		13.9	16.9	27,800	11.8	3,700	617
MW-68	10	3.39	6.26	10,900	ND	1,410	62.8
	20	ND	5.41	17,900	ND	281	53.3
MW-70	5	4.84	8.08	12,300	ND	2,090	56.0
	10	4.91	2.67	4,480	ND	519	131
MW-71	5	9.71	11.40	19,100	ND	1,730	412
	10	ND	13.20	3,240	ND	884	10.9
MW-72	5	2.58	8.96	7,630	ND	1,660	49.7
	10	ND	6.05	5,110	ND	712	9.40
	15	ND	1.36	3,330	ND	121	18.7
MW-73	5	3.29	7.92	10,100	10.2	1,200	69.9
	10	3.68	8.75	8,550	ND	823	8.54
	15	ND	7.01	17,800	ND	854	57.0
MW-74	5	2.44	9.21	4,370	9.02	943	23.0
	15	ND	3.87	5,040	ND	415	12.8
MW-74DUP	15	3.01	4.33	3,440	ND	665	25.6
MW-81	5	6.08	10	14,000	ND	2,690	151
	10	11	9.15	17,100	17	1,180	622
RISB6	5	4.37	9.38	6,560	10.6	821	19.5
	15	6.43	12.7	6,770	ND	1,260	98.2

**Table 7-11 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table)**  
**Collected in AREEs 2 and 5**

Sample ID	Depth bgs (ft)	Nickel (µg/g)	Potassium (µg/g)	Silver (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>		17.9	624	ND	933	25.8	46.3
MW-68	10	4.57	278	ND	345	26.1	16.4
	20	ND	188	ND	346	7.30	ND
MW-70	5	6.17	359	2.08	383	36.8	21.3
	10	ND	163	ND	249	10.5	6.71
MW-71	5	8.52	576	ND	484	37.5	26.7
	10	4.34	336	ND	407	18.5	13.0
MW-72	5	8.12	343	ND	357	27.9	27.2
	10	3.09	182	ND	350	11.6	8.70
	15	ND	ND	ND	244	5.88	ND
MW-73	5	5.50	381	ND	413	34.0	27.1
	10	5.72	216	ND	456	16.9	26.4
	15	4.10	460	ND	541	24.2	23.7
MW-74	5	4.20	264	ND	344	17.8	14.6
	15	2.80	164	ND	432	10.8	8.70
MW-74DUP	15	3.79	428	ND	472	13.0	17
MW-81	5	8.15	460	ND	431	35.8	24.6
	10	8.25	778	ND	332	32.6	37.7
RISB6	5	4.39	430	ND	557	26.9	16.4
	15	5.64	567	ND	535	14.2	24.1

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for subsurface soil samples.



**Table 7-11 (Continued)**  
**Organics Detected in Subsurface Soil Samples (0 to 2 ft bgs) Collected in AREEs 2 and 5**

Sample ID	Bis(2-ethylhexyl)-phthalate (µg/g)	DDT (µg/g)	Di-n-butylphthalate (µg/g)	Endosulfan Sulfate (µg/g)	Methoxychlor (µg/g)
RBC <sup>a</sup>	46	1.9	780	47 <sup>c</sup>	19
MW-68	ND	ND	ND	ND	ND
MW-70	0.63	ND	4.10	ND	ND
MW-71	0.24	0.01	ND	ND	ND
MW-71DUP	0.38	ND	ND	ND	ND
MW-74	ND	ND	ND	ND	ND
MW-81	ND	ND	ND	ND	ND
RISB6	0.21	ND	ND	ND	ND

Sample ID	PCB-1248 (µg/g)	PCB-1254 (µg/g)	TPH, as Diesel (µg/g)	TPH, as Gas (µg/g)
RBC <sup>a</sup>	0.083 <sup>b</sup>	0.16	---	---
MW-68	ND	ND	ND	ND
MW-70	ND	ND	ND	ND
MW-71	ND	ND	ND	ND
MW-71DUP	ND	ND	ND	ND
MW-74	ND	ND	27.9	9.88
MW-81	0.22	1.00	ND	ND
RISB6	ND	ND	ND	ND

ND Not detected

<sup>a</sup> The soil RBC values are from the USEPA Region III Residential RBCs (USEPA, 1996a). RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

<sup>b</sup> Value is for carcinogenic PCBs.

<sup>c</sup> RBC for endosulfan was used.

**Table 7-11 (Continued)**  
**Organics Detected in Subsurface Soil Samples (2 ft bgs to Water Table)**  
**Collected in AREEs 2 and 5**

Sample ID	Depth bgs (ft)	Acetone (µg/g)	Benzoic Acid (µg/g)	Bis(2-ethyl-hexyl) phthalate (µg/g)	Di-n-butyl Phthalate (µg/g)	Endosulfan Sulfate (µg/g)	Methylene Chloride (µg/g)	PCB-1248 (µg/g)	PCB-1254 (µg/g)
RBC <sup>a</sup>		780	31,000	46	780	47 <sup>b</sup>	86	0.083 <sup>c</sup>	0.16
MW-68	10	ND	ND	0.40	ND		ND	ND	ND
	20	0.01	ND	ND	ND	ND	ND	ND	ND
MW-70	5	ND	ND	0.54	3.90	ND	ND	ND	ND
	10	0.01	ND	0.49	3.60	ND	ND	ND	ND
MW-71	5	ND	ND	0.19	ND	ND	ND	ND	ND
	10	ND	ND	ND	ND	ND	ND	ND	ND
MW-72	5	ND	ND	0.81	3.70	ND	ND	ND	ND
	10	ND	ND	1.10	4.30	ND	ND	ND	ND
	15	0.02	ND	1.00	3.50	ND	0.01	ND	ND
MW-73	5	ND	ND	0.21	ND	ND	ND	ND	ND
	10	ND	ND	0.22	ND	ND	ND	ND	ND
	15	ND	ND	0.74	ND	ND	ND	ND	ND
MW-74	5	ND	ND	ND	ND	ND	ND	ND	ND
	15	ND	ND	ND	ND	ND	ND	ND	ND
MW-74	15	ND	0.68	ND	ND	ND	ND	ND	ND
MW-81	5	0.02	ND	ND	ND	ND	ND	ND	ND
	10	ND	ND	ND	ND	ND	ND	0.36	0.16
RISB6	5	ND	ND	0.23	ND	ND	ND	ND	ND
	15	ND	ND	0.23	ND	ND	ND	ND	ND

ND Not detected.

<sup>a</sup> The maximum detected concentrations of organic and inorganic compounds were compared to USEPA Region III residential RBCs, in accordance with Region III guidance (USEPA, 1996a). The RBCs are health-protective chemical concentrations that are back-calculated using toxicity criteria, a  $1 \times 10^{-6}$  target risk level or a 0.1 hazard index, and conservative exposure parameters.

<sup>b</sup> The RBC for endosulfan was used.

<sup>c</sup> Value is for carcinogenic PCBs.

— No value available.

**Table 7-11 (Continued)**  
**Inorganics Detected in Test Pit Samples Collected in AREEs 2 and 5**  
**(greater than 2 feet bgs)**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background <sup>a</sup>		18,200	73.8	1.02	454	25.0
TP-3A	9.4	15,000	ND	0.963	200	14.2
TP-3B	7	20,700	53.3	0.609	436	26.1
TP-4A	6	15,800	375	2.44	8,820	24.4
TP-4B	4	9,480	66.6	1.08	535	22.8

Sample ID	Depth bgs (ft)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)
Site Background <sup>a</sup>		13.9	16.9	27,800	11.8	3,700
TP-3A	9.4	6.82	6.36	14,300	ND	1,150
TP-3B	7	6.79	10.4	16,700	12.5	2,340
TP-4A	6	23.2	47.0	40,400	113	1,960
TP-4B	4	7.40	13.0	18,000	18.9	1,250

Sample ID	Depth bgs (ft)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>		617	17.9	624	933	25.8	46.3
TP-3A	9.4	134	7.59	583	413	27.7	30.3
TP-3B	7	143	9.04	846	465	46.1	42.5
TP-4A	6	3,270	16.8	1,230	1,190	44.3	416
TP-4B	4	211	9.41	892	453	49.4	66.2

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF maximum background concentrations for samples MW-52 through MW-54, each at two depths.

**Table 7-11 (Continued)**  
**Organics Detected in Test Pit Samples Collected in AREES 2 and 5**

Sample ID	Depth bgs (ft)	Methylene Chloride (µg/g)
RBC <sup>a</sup>		85
TP-3A	9.4	ND
TP-3B	7	0.010
TP-4A	6	0.03
TP-4B	4	0.01

ND Not detected.

<sup>a</sup> USEPA Region III residential risk-based concentration (RBC) values.

**Table 7-11 (Continued)**  
**Inorganics Detected in Groundwater Samples Collected in AREEs 2 and 5**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)
Site Background <sup>1</sup>	12,500	6.70	107	0.8	42,200	22.3
MW-1	130	ND	ND	ND	790	ND
MW-2	63.2	ND	38.4	ND	10,600	ND
MW-3	ND	ND	30.1	ND	16,900	ND
MW-4	5,950	ND	52.9	0.1	2,470	23.5
MW-5	150	1.7	58.5	0.1	8,050	ND
MW-68	101	ND	ND	0.2	1,120	ND
MW-68 Round 2	132	ND	ND	ND	888	ND
MW-70	156	ND	32.8	ND	2,530	ND
MW-70 Round 2	263	ND	ND	ND	1,620	ND
MW-71	ND	ND	31.3	ND	2,530	ND
MW-71 Round 2	161	ND	31.9	ND	2,460	ND
MW-71 DUP	ND	ND	30.1	ND	2,460	ND
MW-72	51.6	ND	33.1	ND	2,640	ND
MW-72 Round 2	174	ND	25.0	ND	1,680	ND
MW-73	72.8	ND	31.1	ND	2,850	ND
MW-73 Round 2	232	ND	29.9	ND	3,480	ND
MW-74	ND	ND	52.4	ND	5,180	ND
MW-74 Round 2	188	ND	ND	ND	942	ND
MW-81	416	ND	51.3	ND	20,700	ND
MW-81 Round 2	284	1.7	58.3	ND	26,600	ND
MW-82	242	ND	86.3	ND	12,300	ND
MW-82 Round 2	165	ND	80.3	ND	11,900	ND
MW-83	494	ND	ND	ND	2,690	ND
MW-83 Round 2	1,910	ND	ND	ND	1,590	ND

**Table 7-11 (Continued)**  
**Inorganics Detected in Groundwater Samples Collected in AREEs 2 and 5**

Sample ID	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)
Site Background*	8.9	9,620	6.3	7,720	354	18.4
MW-1	ND	127	15.9	706	ND	ND
MW-2	ND	45.9	ND	5,700	388	ND
MW-3	ND	829	ND	5,880	203	ND
MW-4	8.3	4,290	25.7	2,470	104	28.1
MW-5	ND	14,600	15.5	4,640	74.5	ND
MW-68	ND	75.8	ND	837	32.1	ND
MW-68 Round 2	ND	98.3	3.3	677	14.4	ND
MW-70	ND	157	ND	2,890	153	ND
MW-70 Round 2	ND	188	1.2	2,230	95.6	ND
MW-71	ND	ND	ND	2,160	46.3	ND
MW-71 Round 2	ND	126	2.9	2,390	45.5	ND
MW-71DUP	ND	ND	ND	2,140	44.5	ND
MW-72	ND	144	6.6	1,790	70.1	ND
MW-72 Round 2	ND	136	1.9	1,580	34.6	ND
MW-73	ND	1,310	ND	1,380	80.1	ND
MW-73 Round 2	ND	558	1.6	1,570	64.2	ND
MW-74	ND	3,290	ND	2,650	115	ND
MW-74 Round 2	ND	309	1.4	559	40.4	ND
MW-81	ND	2,720	ND	3,960	353	ND
MW-81 Round 2	ND	2,990	ND	3,730	324	18.8
MW-82	ND	12,500	ND	6,440	547	ND
MW-82 Round 2	ND	9,520	ND	5,890	491	ND
MW-83	ND	3,750	ND	845	225	ND
MW-83 Round 2	5.7	4,470	1.4	801	275	ND

**Table 7-11 (Continued)**  
**Inorganics Detected in Groundwater Samples Collected in AREEs 2 and 5**

Sample ID	Potassium (µg/L)	Selenium (µg/L)	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
Site Background <sup>a</sup>	20,600	4.2	43,500	0.1	29.8	46
MW-1	ND	ND	8,530	ND	ND	51
MW-2	1,100	ND	3,390	ND	ND	ND
MW-3	1,310	ND	4,640	ND	ND	ND
MW-4	1,260	ND	5,610	0.1	10.7	85.4
MW-5	1,890	ND	26,400	ND	ND	ND
MW-68	ND	ND	8,710	ND	ND	ND
MW-68 Round 2	607	ND	9,120	ND	ND	26.3
MW-70	ND	2.5	17,600	ND	ND	23.9
MW-70 Round 2	588	ND	9,680	ND	ND	40.0
MW-71	714	ND	5,350	ND	ND	ND
MW-71 Round 2	971	ND	4,730	ND	ND	ND
MW-71 DUP	648	ND	5,170	ND	ND	ND
MW-72	ND	ND	7,380	ND	ND	24.4
MW-72 Round 2	614	ND	5,710	ND	ND	33.6
MW-73	1,040	ND	5,550	ND	ND	21.7
MW-73 Round 2	1,530	ND	5,440	ND	ND	ND
MW-74	868	3.1	25,600	ND	ND	25.9
MW-74 Round 2	966	ND	18,200	ND	ND	ND
MW-81	3,740	2.5	5,910	ND	ND	ND
MW-81 Round 2	7,520	2.6	6,580	ND	ND	ND
MW-82	3,230	ND	34,300	ND	ND	ND
MW-82 Round 2	2,890	2.5	27,700	ND	ND	22.8
MW-83	1,290	ND	3,360	ND	ND	ND
MW-83 Round 2	1,430	ND	3,230	ND	ND	ND

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF maximum background concentrations for groundwater.

<sup>b</sup> Round 2 sampling was conducted in March 1996.

**Table 7-11 (Continued)**  
**Organics Detected in Groundwater Samples Collected in AREEs 2 and 5**

Sample ID	1-Methyl naphthalene (µg/L)	4-Methyl Phenol (µg/L)	Acenaphthylene (µg/L)	Aldrin (µg/L)	Anthracene (µg/L)	Benzoic Acid (µg/L)	Alpha BHC (µg/L)
RBC*	110	18	110	0.004	1,100	15,000	—
MW-1	ND	ND	ND	ND	ND	ND	ND
MW-2	ND	ND	ND	ND	ND	ND	ND
MW-3	ND	ND	ND	ND	ND	ND	ND
MW-4	ND	ND	ND	ND	ND	ND	ND
MW-5	ND	ND	ND	ND	ND	ND	ND
MW-68	ND	ND	ND	ND	ND	ND	ND
MW-68 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-70	ND	ND	ND	ND	0.177	ND	ND
MW-70 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-71	ND	ND	ND	ND	ND	ND	ND
MW-71 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-71DUP	ND	ND	ND	ND	ND	ND	0.006
MW-72	ND	ND	ND	ND	ND	ND	ND
MW-72 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-73	ND	ND	ND	ND	0.203	ND	ND
MW-73 Round 2	ND	ND	ND	ND	ND	ND	0.008
MW-74	ND	ND	ND	ND	ND	ND	ND
MW-74 Round 2	ND	ND	ND	0.010	ND	ND	0.008
MW-81	ND	3.6	ND	ND	2.91	7.3	ND
MW-81 Round 2	ND	11	ND	ND	ND	25	0.008
MW-82	3.38	ND	6.49	0.009	1.32	ND	ND
MW-82 Round 2	ND	ND	ND	ND	ND	ND	0.033
MW-83	ND	ND	ND	ND	ND	ND	ND
MW-83 Round 2	ND	ND	ND	ND	ND	ND	0.008



**Table 7-11 (Continued)**  
**Organics Detected in Groundwater Samples Collected in AREEs 2 and 5**

Sample ID	Gamma-BHC (Lindane) (µg/L)	Bis(2-ethyl hexyl) Phthalate (µg/L)	DDT (µg/L)	Dimethyl Phthalate (µg/L)	Endosulfan Sulfate (µg/L)	Endosulfan II (µg/L)	Endrin (µg/L)
RBC*	0.052	4.8	0.2	37,000	22	—	1.1
MW-1	ND	ND	ND	ND	ND	ND	ND
MW-2	ND	ND	ND	ND	ND	ND	ND
MW-3	ND	ND	ND	ND	ND	ND	ND
MW-4	ND	45	ND	ND	ND	ND	ND
MW-5	ND	6	ND	ND	ND	ND	ND
MW-68	ND	5.2	ND	ND	ND	ND	ND
MW-68 Round 2	0.007	3.5	ND	ND	ND	ND	ND
MW-70	ND	2.3	ND	ND	ND	ND	ND
MW-70 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-71	ND	46	ND	ND	ND	ND	ND
MW-71 Round 2	ND	4.9	ND	ND	ND	ND	ND
MW-71DUP	ND	19	ND	ND	ND	ND	ND
MW-72	ND	2.6	ND	ND	ND	ND	ND
MW-72 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-73	ND	2	ND	ND	0.016	ND	ND
MW-73 Round 2	ND	ND	ND	ND	0.016	ND	ND
MW-74	ND	6.6	ND	ND	ND	ND	ND
MW-74 Round 2	ND	ND	ND	ND	ND	ND	0.012
MW-81	ND	29	ND	ND	ND	ND	ND
MW-81 Round 2	ND	2.5	ND	ND	ND	ND	ND
MW-82	0.214	13	0.051	5.3	0.033	0.031	0.022
MW-82 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-83	ND	13	ND	ND	ND	ND	ND
MW-83 Round 2	ND	2.1	ND	ND	ND	ND	ND

**Table 7-11 (Continued)**  
**Organics Detected in Groundwater Samples Collected in AREEs 2 and 5**

Sample ID	Fluoranthene (µg/L)	Gamma Chlordane (µg/L)	Heptachlor Epoxide (µg/L)	Methoxychlor (µg/L)	Phenanthrene (µg/L)	Phenol (µg/L)	Pyrene (µg/L)
RBC <sup>a</sup>	150	0.052	0.0012	18	110 <sup>b</sup>	2,200	110
MW-1	ND	ND	ND	ND	ND	ND	ND
MW-2	ND	ND	ND	ND	ND	ND	ND
MW-3	ND	ND	ND	ND	ND	ND	ND
MW-4	ND	ND	ND	ND	ND	ND	ND
MW-5	ND	ND	ND	ND	ND	ND	ND
MW-68	ND	ND	ND	ND	ND	ND	ND
MW-68 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-70	ND	ND	ND	ND	ND	ND	ND
MW-70 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-71	ND	ND	ND	ND	ND	ND	ND
MW-71 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-71DUP	ND	ND	ND	ND	ND	ND	ND
MW-72	ND	ND	ND	ND	ND	ND	ND
MW-72 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-73	0.023	ND	ND	ND	ND	ND	ND
MW-73 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-74	ND	ND	ND	ND	ND	ND	ND
MW-74 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-81	0.041	ND	ND	ND	2.77	5.9	ND
MW-81 Round 2	ND	ND	ND	ND	ND	14	ND
MW-82	0.052	0.012	0.035	ND	4.03	ND	0.551
MW-82 Round 2	ND	ND	ND	ND	ND	ND	ND
MW-83	ND	ND	ND	0.012	ND	ND	ND
MW-83 Round 2	ND	ND	ND	ND	ND	ND	ND

ND Not detected.  
<sup>a</sup> Groundwater RBC values are from USEPA Region III Tap Water RBCs. RBCs for noncarcinogenic chemicals are based on hazard quotient of 0.1, following USEPA Region III guidance.  
<sup>b</sup> The RBC for pyrene was used as a surrogate for non-carcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.  
 -- No value available.

**Table 7-11 (Continued)**  
**Inorganics Detected in Sediment Samples Collected from AREEs 2 and 5**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)
Site Background <sup>a</sup>	16,900	176	1.38	6,000	33.7	21.4	44.4	36,500
RISD11	13,700	ND	ND	3,060	21.4	10.2	20.7	24,500
RISD12	13,200	ND	1.38	4,440	21.2	13.1	29.2	20,400
RISD13	14,700	ND	1.26	4,380	28.8	20.1	35.6	26,200

Sample ID	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	42.2	3,740	1,890	30.3	2,120	1,710	54.1	168
RISD11	ND	2,140	284	15.4	1,060	2,650	47.6	85.5
RISD12	ND	2,460	287	19.1	969	2,450	60.9	100
RISD13	35.3	3,200	874	22.5	1,610	1,530	64.4	139

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for sediment samples.

**Table 7-11 (Continued)**  
**Organics Detected in Sediment Samples Collected from AREEs 2 and 5**

Sample ID	1-Methylnaphthalene (µg/g)	2-Methylnaphthalene (µg/g)	Acenaphthene (µg/g)	Acenaphthylene (µg/g)	Acetone (µg/g)	Alpha-chlordane (µg/g)	Anthracene (µg/g)	Benzo(a)anthracene (µg/g)	Benzo(a)pyrene (µg/g)	Benzo(b)fluoranthene (µg/g)
RBC <sup>a</sup>	230 <sup>b</sup>	230 <sup>b</sup>	470	230 <sup>b</sup>	780	0.49	2,300	0.88	0.088	0.88
RISD11	0.479	ND	0.867	ND	ND	ND	0.331	0.016	ND	ND
RISD12	2.41	ND	1.59	ND	ND	ND	0.979	0.026	0.198	0.132
RISD13	ND	ND	ND	ND	0.05	ND	0.102	0.024	0.036	0.07

Sample ID	Benzo(g,h,i) perylene (µg/g)	Benzo(k)fluoranthene (µg/g)	Benzoic Acid (µg/g)	Bis(2-ethylhexyl) phthalate (µg/g)	Chrysene (µg/g)	Chlordane (µg/g)	DDD (µg/g)	DDE (µg/g)	Dibenzo(a,h)anthracene (µg/g)	Diethyl phthalate (µg/g)
RBC <sup>a</sup>	230 <sup>b</sup>	8.8	31,000	46	88	0.49	2.7	1.9	0.088	6,300
RISD11	0.162	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD12	ND	0.07	ND	ND	ND	ND	ND	ND	ND	ND
RISD13	ND	0.021	ND	ND	ND	ND	ND	ND	ND	ND

Sample ID	Fluoranthene (µg/g)	Fluorene (µg/g)	Gamma-chlordane (µg/g)	Indeno(1,2,3-cd)pyrene (µg/g)	Naphthalene (µg/g)	PCB-1260 (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)	TPH, as Diesel (µg/g)
RBC <sup>a</sup>	310	310	0.049	0.88	310	0.083 <sup>c</sup>	230 <sup>b</sup>	230	—
RISD11	0.045	ND	ND	ND	1.11	ND	ND	0.103	35.6
RISD12	0.095	ND	ND	0.66	1.88	ND	ND	0.081	57.8
RISD13	0.07	0.151	ND	0.069	ND	ND	ND	0.159	ND

ND Not detected.

<sup>a</sup> Sediment RBC values are from USEPA Region III Residential Soil RBCs. RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

<sup>b</sup> The RBC for pyrene was used as a surrogate for non-carcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>c</sup> Value is for carcinogenic PCBs.

-- No value available.

**Table 7-11 (Continued)**  
**Inorganics Detected in Surface Water Samples Collected from AREEs 2 and 5**

Sample ID Site Background <sup>a</sup>	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)
	1,930	1.4	41.8	ND	22,200	10.8	ND	2,510	1.9
RISW11	1,800	ND	ND	ND	3,470	ND	ND	2,110	1.2
RISW12	2,100	ND	ND	ND	3,920	ND	ND	2,770	1.6
RISW13	3,460	ND	54.3	ND	183	ND	6.1	4,110	5.2

Sample ID Site Background <sup>a</sup>	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
	7,500	303	ND	3,670	ND	16,500	ND	ND	ND
RISW11	1,840	56.1	ND	2,650	ND	2,480	ND	ND	ND
RISW12	2,070	91.2	ND	2,910	ND	3,320	ND	ND	ND
RISW13	6,310	183	ND	4,490	ND	13,800	ND	10.8	ND

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for surface water samples.

**Table 7-11 (Continued)**  
**Inorganics Detected In Surface Water Runoff Samples Collected In AREEs 2 and 5**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)
SWR010	2,570	1.2	86.3	0.1	7,020	ND
SWR011	30,200	2.9	178	0.6	6,880	40.9
SWR012	1,080	ND	72.1	ND	6,220	ND

Sample ID	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)
SWR010	ND	15,800	5.3	4,610	863	ND	1,250
SWR011	33.0	31,100	45.9	4,640	571	16.1	6,240
SWR012	ND	20,790	1.3	4,450	1,390	ND	1,920

Sample ID	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
SWR010	9,720	ND	12.2	27.2
SWR011	1,460	0.4	82.5	723
SWR012	5,640	ND	ND	86.0

ND Not detected.

**Table 7-11 (Continued)**  
**Organics Detected In Surface Water Runoff Samples Collected In AREEs 2 and 5**

Sample ID	Anthracene (µg/L)	DDE (µg/L)	DDT (µg/L)	Endosulfan Sulfate (µg/L)	Fluoranthene (µg/L)	Pyrene (µg/L)
SWR010	ND	ND	ND	0.105	0.023	ND
SWR011	0.161	0.012	0.018	ND	0.022	0.137
SWR012	ND	ND	ND	0.495	ND	ND

ND Not detected.

**Table 7-12**  
**Summary of RI Results for AREE 3 and 6A - Potential Dump Nos. 3 and 6A**

Media Sampled <sup>a</sup>	Number of Samples Collected	Compounds/Analytes Detected above LOC <sup>b</sup>	Summary of Fate & Transport
Surface Soil	12	Al, As, Be, Cr, Cu, Na, Ni, K, Pb, Se	Infiltration/percolation through soil
Subsurface Soil (0-2 feet bgs)	1	As, Cr, Pb, k, PCB-1248, PCB-1254, V	Infiltration/percolation through soil
Subsurface Soil (2 ft. to water table)	2	None	Infiltration/percolation through soil
Test Pits	12	Al, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Pb, Mg, Ni, K, Sb, V, Zn	Former potential dumping area's
Groundwater - Round 1	1	Fe, Mg	Discharge to surface water
Groundwater - Round 2	1	Fe, Mg	
Sediment	1	None	Stormwater runoff to surface water/sediments
Surface Water	1	None	Stormwater runoff to surface water/sediments
Surface Water Runoff	2	None	Stormwater runoff to surface water/sediments

<sup>a</sup> Surface soil, subsurface soil, test pit, and groundwater samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals. If PCBs were detected, the laboratory was instructed to analyze for PCTs. Surface soil and groundwater samples were also analyzed for PAHs.

<sup>b</sup> LOC - Level of Concern. Refers to either the WRF site background maximum concentrations for inorganics or USEPA Region III residential risk-based concentrations (RBCs) for organics.



**Table 7-12 (Continued)**  
**Inorganics Detected in Surface Soil Samples Collected in AREE 3 and 6A**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)
Site Background <sup>a</sup>	14,350	92.4	0.814	1,150	31.3	16.6
RISS10	15,500	ND	0.804	280	26.4	7.25
RISS11	6,630	ND	0.721	260	17.8	10.4
RISS11DUP	6,720	ND	0.520	288	17.4	12.8
RISS12	10,100	51.8	0.576	235	21.4	7.52
RISS17	12,700	ND	0.695	215	24.9	7.65
RISS18	13,600	ND	0.518	286	18.4	4.49
RISS19	9,970	ND	0.444	461	14.9	3.96
RISS20	12,500	ND	0.458	252	17.7	3.70
RISS21	12,200	ND	0.777	477	23.7	6.35
RISS21DUP	14,000	51.1	0.881	530	26.9	6.96
RISS22	16,300	ND	0.825	152	28.0	6.00
RISS23	13,800	ND	0.682	450	23.5	5.94

Sample ID	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)
Site Background <sup>a</sup>	12.6	28,100	22.4	2,610	875	11.9
RISS10	12.7	20,000	9.54	2,250	100	11.4
RISS11	7.79	14,100	ND	1,320	67.2	9.36
RISS11DUP	7.69	11,700	ND	1,400	79.3	9.12
RISS12	9.31	13,600	ND	1,570	53.8	8.84
RISS17	5.45	22,100	19.7	999	227	6.36
RISS18	6.63	15,200	12.7	988	49.6	6.93
RISS19	8.60	12,700	17.9	909	49.5	6.67
RISS20	5.63	15,400	11.8	965	39.9	5.65
RISS21	16.4	18,800	13.9	2,130	55.8	10.3
RISS21DUP	17.9	21,200	14.7	2,300	67.7	12.0
RISS22	16.8	26,000	13.5	2,330	69.3	11.3
RISS23	12.5	19,000	12.5	1,640	65.5	9.21

**Table 7-12 (Continued)**  
**Inorganics Detected in Surface Soil Samples Collected in AREE 3 and 6A**

Sample ID	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	936	14.2	487	58.9	43.9
RISS10	1,020	ND	496	45.3	36.9
RISS11	533	ND	426	22.0	19.5
RISS11DUP	504	ND	426	21.9	21.1
RISS12	651	ND	487	31.7	24.1
RISS17	628	ND	446	43	28.6
RISS18	922	ND	482	31.4	29.1
RISS19	930	ND	421	29	27.9
RISS20	707	ND	455	33	25.9
RISS21	844	17.7	534	40.7	42.4
RISS21DUP	950	20	535	47.1	46.7
RISS22	1,080	24.5	544	53.2	40.6
RISS23	958	ND	500	38.3	37.2

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for surface soil samples MW-52 through MW-54 and RIBKSS1 through RIBKSS5.

**Table 7-12 (Continued)**  
**Organics Detected in Surface Soil Samples Collected in AREE 3 and 6A**

Sample ID	Acenaphthene (µg/g)	Anthracene (µg/g)	Benzo(a)anthracene (µg/g)	Benzo(a)pyrene (µg/g)	Benzo(b)- fluoranthene (µg/g)
RBC <sup>a</sup>	470	2,300	0.88	0.088	0.88
RISS10	ND	ND	ND	ND	ND
RISS11	ND	0.012	ND	ND	ND
RISS11DUP	ND	0.017	ND	ND	ND
RISS12	ND	0.035	ND	ND	ND
RISS17	ND	0.039	0.003	0.004	0.006
RISS18	ND	0.032	0.002	0.003	0.008
RISS19	3.32	0.015	0.004	0.005	0.015
RISS20	ND	0.032	0.002	0.002	0.006
RISS21	ND	0.012	0.002	0.001	0.006
RISS21DUP	ND	ND	0.002	0.001	0.005
RISS22	ND	ND	ND	ND	ND
RISS23	ND	ND	ND	ND	0.004

Sample ID	Benzo(g,h,i) perylene (µg/g)	Benzo(k) fluoranthene (µg/g)	Bis(2- ethylhexyl)- phthalate (µg/g)	Fluoranthene (µg/g)	Indeno(1,2,3-cd)- pyrene (µg/g)	Methylene chloride (µg/g)
RBC <sup>a</sup>	230 <sup>b</sup>	8.8	46	310	0.88	85
RISS10	ND	ND	ND	ND	ND	0.020
RISS11	ND	ND	8.20	ND	ND	0.010
RISS11DUP	ND	ND	0.970	ND	ND	0.010
RISS12	ND	ND	ND	ND	ND	ND
RISS17	ND	0.003	ND	0.015	ND	0.020
RISS18	ND	0.004	ND	0.012	0.005	0.020
RISS19	0.015	0.006	ND	0.011	0.012	ND
RISS20	ND	0.003	ND	0.024	ND	ND
RISS21	ND	0.003	ND	0.004	0.005	ND
RISS21DUP	ND	0.002	ND	0.004	ND	ND
RISS22	ND	ND	ND	ND	ND	ND
RISS23	ND	0.002	ND	0.005	ND	ND

**Table 7-12 (Continued)**  
**Organics Detected in Surface Soil Samples Collected in AREE 3 and 6A**

Sample ID	Naphthalene (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)
RBC <sup>a</sup>	310	230 <sup>b</sup>	230
RISS10	ND	ND	ND
RISS11	ND	ND	ND
RISS11DUP	ND	ND	ND
RISS12	ND	ND	ND
RISS17	ND	ND	0.011
RISS18	ND	ND	ND
RISS19	1.82	0.191	ND
RISS20	ND	ND	0.009
RISS21	ND	ND	ND
RISS21DUP	ND	ND	ND
RISS22	ND	ND	ND
RISS23	ND	ND	ND

ND Not detected.

<sup>a</sup> The maximum detected concentrations of organic and inorganic compounds were compared to USEPA Region III residential RBCs, in accordance with Region III guidance (USEPA, 1996a). The RBCs are health-protective chemical concentrations that are back-calculated using toxicity criteria, a  $1 \times 10^{-6}$  target risk level or a 0.1 hazard index, and conservative exposure parameters.

<sup>b</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

**Table 7-12 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (0 to 2 ft bgs) Collected in AREEs 3 and 6A**

Sample ID	Aluminum (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background <sup>a</sup>	14,350	3.80	92.4	0.814	1,150	31.3
MW-69	16,000	2.85	51.9	0.71	282	25.3

Sample ID	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Mercury (µg/g)
Site Background <sup>a</sup>	15.6	12.6	28,100	22.4	2,610	875	ND
MW-69	8.20	11.6	26,200	13.8	1,630	86.9	ND

Sample ID	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	11.9	938	14.2	487	58.9	43.9
MW-69	9.88	764	15.5	453	44.2	36.7

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for subsurface soil samples.

**Table 7-12 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table) Collected in AREEs 3 and 6A**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Antimony (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background <sup>a</sup>		18,200	ND	73.8	1.02	454	25.0
MW-69	25	1,480	ND	ND	ND	ND	4.11
	27	659	ND	ND	ND	ND	2.13

Sample ID	Depth bgs (ft)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background <sup>a</sup>		13.9	16.9	27,800	11.8	3,700	617
MW-69	25	ND	2.30	1,620	ND	442	15.4
	27	ND	1.06	836	ND	182	7.56

Sample ID	Depth bgs (ft)	Nickel (µg/g)	Potassium (µg/g)	Silver (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>		17.9	624	ND	933	25.8	46.3
MW-69	25	ND	248	ND	305	4.93	6.55
	27	ND	156	ND	317	ND	ND

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for subsurface soil samples.

**Table 7-12 (Continued)**  
**Organics Detected in Subsurface Soil Samples (0 to 2 ft bgs) Collected in AREEs 3 and 6A**

Sample ID	Bis(2-ethylhexyl)- phthalate (µg/g)	DDT (µg/g)	Di-n- butylphthalate (µg/g)	Endosulfan Sulfate (µg/g)	Methoxychlor (µg/g)
RBC <sup>a</sup>	46	1.9	---	47	39
MW-69	ND	ND	ND	0.02	ND

Sample ID	PCB-1248 (µg/g)	PCB-1254 (µg/g)	TPH, as Diesel (µg/g)	TPH, as Gas (µg/g)
RBC <sup>a</sup>	0.093 <sup>b</sup>	0.16 <sup>b</sup>	100	100
MW-69	ND	ND	ND	ND

Sample ID	Depth bgs (ft)	Acetone (µg/g)	Benzoic Acid (µg/g)	Bis(2- ethyl-hexyl) phthalate (µg/g)	Di-n-butyl Phthalate (µg/g)	Endosulfan Sulfate (µg/g)	Methylene Chloride (µg/g)	PCB-1248 (µg/g)	PCB-1254 (µg/g)
RBC <sup>a</sup>		790	31,000	46	---	47 <sup>b</sup>	85	0.093 <sup>c</sup>	0.16
MW-69	25	0.01	ND	ND	ND	ND	ND	ND	ND
	27	0.02	ND	ND	ND	0.03	ND	ND	ND

ND Not detected.

<sup>a</sup> USEPA Region III residential risk-based concentration (RBC) values.

<sup>b</sup> The RBC for endosulfan was used.

<sup>c</sup> Value is for carcinogenic PCBs.

--- No value available.

**Table 7-12 (Continued)**  
**Inorganics Detected in Test Pit Samples Collected in AREE 3 and 6A**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Antimony (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Cadmium (µg/g)
Site Background <sup>a</sup> (0-2ft bgs)		14,350	ND	3.8	92.4	0.814	ND
Site Background <sup>a</sup> (2ft-water table)		18,200	ND	ND	73.8	1.02	ND
TP-13A	6.5	6,410	ND	ND	ND	0.612	ND
TP-13B	5.0	5,610	ND	ND	ND	0.614	ND
TP-14A	4.0	10,600	ND	ND	48.8	1.16	ND
TP-14ADUP	4.0	7,890	ND	ND	ND	0.895	ND
TP-14B	7.0	5,590	ND	ND	ND	0.721	ND
TP-15A	1.0	12,200	ND	ND	ND	0.562	ND
TP-15B	4.0	12,900	0.522	NA	64.8	0.444	1.02
TP-16A	3.0	15,500	ND	ND	ND	0.312	ND
TP-16ADUP	3.0	15,900	ND	NA	52.2	0.549	ND
TP-16B	3.33	9,550	ND	ND	52.4	0.848	ND
TP-17A	6.0	12,300	ND	ND	506	0.725	ND
TP-17B	0.0	18,300	ND	ND	ND	0.754	ND

Sample ID	Depth bgs (ft)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)
Site Background <sup>a</sup> (0-2 ft bgs)		1,150	31.3	16.6	12.6	28,100	22.4
Site Background <sup>a</sup> (2ft-water table)		454	25.0	13.9	16.9	27,800	11.8
TP-13A	6.5	489	19.0	20.3	6.68	7,320	ND
TP-13B	5.0	359	15.7	21.5	7.03	7,810	ND
TP-14A	4.0	179	17.6	6.89	7.61	21,000	12.1
TP-14ADUP	4.0	129	13.7	6.87	10.6	12,200	13.9
TP-14B	7.0	142	12.1	3.70	5.19	6,930	ND
TP-15A	1.0	941	34.5	11.1	50.3	67,300	67.0
TP-15B	4.0	21,500	26.0	4.78	15.8	20,400	24.0
TP-16A	3.0	913	25.0	4.94	22.1	24,400	17.0
TP-16ADUP	3.0	743	25.2	3.81	13.0	16,700	19.5
TP-16B	3.33	1,150	19.7	7.32	36.9	18,600	49.8
TP-17A	6.0	836	27.2	24.1	26.6	18,300	9.52
TP-17B	0.0	242	24.1	5.68	11.0	30,400	11.6



**Table 7-12 (Continued)**  
**Inorganics Detected in Test Pit Samples Collected in AREE 3 and 6A**

Sample ID	Depth bgs (ft)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup> (0-2ft bgs)		2,610	875	11.9	936	487	58.9	43.9
Site Background <sup>a</sup> (2ft-water table)		3,700	617	17.9	624	933	25.8	46.3
TP-13A	6.5	2,110	184	16.4	647	626	28.9	41.4
TP-13B	5.0	1,620	201	10.5	535	459	19.2	28.0
TP-14A	4.0	1,110	59.6	7.29	456	447	33.4	34.4
TP-14ADUP	4.0	1,080	50.2	6.09	335	512	25.3	26.3
TP-14B	7.0	661	29.0	3.61	289	404	20.2	21.0
TP-15A	1.0	1,410	158	35.7	635	449	43.1	242
TP-15B	4.0	1,180	303	9.88	830	644	34.4	610
TP-16A	3.0	1,780	67.5	9.81	1,170	444	40.4	350
TP-16ADUP	3.0	1,660	50.6	9.06	1,290	391	41.3	159
TP-16B	3.33	1,510	56.3	7.74	626	456	42.9	189
TP-17A	6.0	3,880	138	17.3	727	610	44.0	41.4
TP-17B	0.0	1,150	48.7	7.72	905	458	38.5	32.2

ND Not detected.

NA Not available.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for surface soils (0-2 feet. bgs) and subsurface soils (2 feet to water table).

**Table 7-12 (Continued)**  
**Organics Detected in Test Pit Samples Collected in AREE 3 and 6A**

Sample ID	Benzo(a)anthracene (µg/g)	Benzo(a)pyrene (µg/g)	Benzo(b)fluoranthene (µg/g)	Benzo(k)fluoranthene (µg/g)
<b>RBC*</b>	<b>0.88</b>	<b>0.088</b>	<b>0.88</b>	<b>8.8</b>
TP-13A	ND	ND	ND	ND
TP-13B	ND	ND	ND	ND
TP-14A	ND	ND	ND	ND
TP-14AD	ND	ND	ND	ND
TP-14B	ND	ND	ND	ND
TP-15A	ND	ND	ND	ND
TP-15B	ND	ND	ND	ND
TP-16A	ND	ND	ND	ND
TP-16AD	ND	ND	ND	ND
TP-16B	0.690	0.440	0.640	0.740
TP-17A	ND	ND	ND	ND
TP-17B	ND	ND	ND	ND

**Table 7-12 (Continued)**  
**Organics Detected in Test Pit Samples Collected in AREE 3 and 6A**

Sample ID	Chrysene (µg/g)	Fluoranthene (µg/g)	Indeno(1,2,3-cd)- pyrene (µg/g)	Pyrene (µg/g)
RBC <sup>a</sup>	88	310	0.88	230
TP-13A	ND	ND	ND	ND
TP-13B	ND	ND	ND	ND
TP-14A	ND	ND	ND	ND
TP-14AD	ND	ND	ND	ND
TP-14B	ND	ND	ND	ND
TP-15A	ND	ND	ND	ND
TP-15B	ND	ND	ND	ND
TP-16A	ND	ND	ND	ND
TP-16AD	ND	ND	ND	ND
TP-16B	1.20	0.380	0.210	0.480
TP-17A	ND	ND	ND	ND
TP-17B	ND	ND	ND	ND

ND Not detected.

<sup>a</sup> USEPA Region III residential risk-based concentration (RBC) values (USEPA 1996). RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

**Table 7-12 (Continued)**  
**Inorganics Detected in Groundwater Samples Collected in AREEs 3 and 6A**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)
Site Background <sup>a</sup>	12,500	6.70	107	0.3	42,200	22.3
MW-69	77.2	1.4	83.1	ND	11,200	ND
MW-69 Round 2	98.6	2.2	70.6	ND	11,400	ND

Sample ID	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)
Site Background <sup>a</sup>	8.9	9,620	6.3	7,720	354	18.4
MW-69	ND	25,800	ND	8,210	641	ND
MW-69 Round 2	ND	20,300	ND	7,160	575	ND

Sample ID	Potassium (µg/L)	Selenium (µg/L)	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
Site Background <sup>a</sup>	20,600	4.2	43,500	0.1	29.8	46
MW-69	2,190	4.7	38,800	ND	ND	ND
MW-69 Round 2	2,040	3.0	33,400	ND	ND	ND

ND Not detected.

NS Not sampled.

<sup>a</sup> Site background concentrations are based on WRF maximum background concentrations for groundwater.

<sup>b</sup> Round 2 sampling was conducted in March, 1996.

**Table 7-12 (Continued)**  
**Organics Detected in Groundwater Samples Collected in AREEs 3 and 6A**

Sample ID	Anthracene (µg/L)	Bis(2-ethyl hexyl) Phthalate (µg/L)	Heptachlor (µg/L)
RBC <sup>a</sup>	1.100	4.8	0.002
MW-69	0.25	2.4	ND
MW-69 Round 2	ND	ND	0.011

ND Not detected.

<sup>a</sup> Groundwater RBC values are from USEPA Region III Tap Water RBCs. RBCs for noncarcinogenic chemicals are based on hazard quotient of 0.1, following USEPA Region III guidance.

**Table 7-12 (Continued)**  
**Inorganics Detected In Sediment Samples Collected In AREE 3 and 6A**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)
Site Background <sup>a</sup>	15,200	175	1.26	6,000	30.1	20.7	41.8
RISD10	13,200	85.2	0.747	989	25	8.97	19.6

Sample ID	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)
Site Background <sup>a</sup>	34,200	42.2	3,470	1,690	30.0	2,120
RISD10	13,800	16.4	2,600	92.8	14.7	1,130

Sample ID	Silver (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	ND	1,710	52.5	157
RISD10	ND	657	37.1	72.5

ND Not detected.

<sup>a</sup> Site background concentrations are maximum concentrations from samples RISDBK-1 through RISDBK-5.

**Table 7-12 (Continued)**  
**Organics Detected In Sediment Samples Collected In AREE 3 and 6A**

Sample ID	2-Methyl-naphthalene (µg/g)	Acenaphthene (µg/g)	Acetone (µg/g)	Anthracene (µg/g)	Benzo(a)anthracene (µg/g)	Benzo(a)pyrene (µg/g)
RBC <sup>a</sup>	230 <sup>b</sup>	470	780	2,300	0.88	0.088
RISD10	ND	ND	ND	0.031	ND	0.002

Sample ID	Benzo(b)fluoranthene (µg/g)	Benzo(g,h,i)perylene (µg/g)	Benzo(k)fluoranthene (µg/g)	Chrysene (µg/g)	DDD (µg/g)	DDE (µg/g)
RBC <sup>a</sup>	0.88	230 <sup>b</sup>	8.8	88	2.7	1.9
RISD10	0.004	ND	0.002	ND	ND	ND

Sample ID	DDT (µg/g)	Dibenzo(a,h)anthracene (µg/g)	Fluoranthene (µg/g)	Indeno(1,2,3-cd)pyrene (µg/g)	PCB-1260 (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)
RBC <sup>a</sup>	1.9	0.088	310	0.88	0.083 <sup>c</sup>	230 <sup>b</sup>	230
RISD10	ND	ND	0.006	ND	ND	ND	ND

ND Not detected.

<sup>a</sup> Sediment RBC values are from USEPA Region III Residential Soil RBCs. RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

<sup>b</sup> The RBC for pyrene was used as a surrogate for non-carcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>c</sup> Value is for carcinogenic for PCBs.

**Table 7-12 (Continued)**  
**Inorganics Detected in Surface Water Samples Collected in AREE 3 and 6A**

SampleID	Aluminum (µg/L)	Barium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)
Site Background <sup>a</sup>	1,930	41.8	22,200	10.8	ND	2,510
RISW10	547	ND	2,020	ND	ND	705

Sample ID	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Potassium (µg/L)	Sodium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
Site Background <sup>a</sup>	1.9	7,500	303	3,670	16,500	ND	ND
RISW10	ND	1,250	28.3	2,010	1,380	ND	ND

ND Not detected.

<sup>a</sup> Site background concentrations are from samples RISWBK-1 through RISWBK-5.



**Table 7-12 (Continued)**  
**Inorganics Detected In Surface Water Runoff Samples Collected In AREE 3 and 6A**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)
SWR05	19,200	1.5	147	1.0	6,130	32.1
SWR09	12,800	ND	55.3	0.1	4,160	20.1

Sample ID	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)
SWR05	65.9	21,700	21.9	5,260	251	29.8	4,400
SWR09	12.0	15,100	8.5	3,740	125	ND	2,940

Sample ID	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
SWR05	5,930	0.3	55.3	456
SWR09	5,680	0.2	36.0	51.3

ND Not detected.

**Table 7-12 (Continued)**  
**Organics Detected In Surface Water Runoff Samples Collected In AREE 3 and 6A**

Sample ID	Anthracene (µg/L)	Fluoranthene (µg/L)	Pyrene (µg/L)
SWR05	2.52	0.033	0.224
SWR09	ND	ND	ND

ND Not detected.

**Table 7-13**  
**Summary of RI Results for AREE 4 - Former Dump No. 4**

Media Sampled <sup>a</sup>	Number of Samples Collected	Compounds/Analytes Detected above LOC <sup>b</sup>	Summary of Fate & Transport
Surface Soil	4	Pb, K, Na	Infiltration/percolation through soil to groundwater  Stormwater runoff to surface water/sediments
Subsurface Soil (0- to 2-ft bgs)	5	Cu, Na benzo(a)pyrene	
Subsurface Soil (2-ft bgs to water table)	8	Ba, Ca, Cr, Co, Cu, Mg, Ni, K, V, Zn	
Test Pits	16	Al, Ba, Be, Cu, Cr, Co, Cu, Fe, Pb, Mg, Ni, K, Na, V, Zn	
Groundwater	Round 1: 5 Round 2: 4	Co, Fe, Mn, Zn	Discharge to surface water
Surface Water Runoff	2	None	Storm water runoff

<sup>a</sup> Surface soil, subsurface soil, test pit, and groundwater samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH. Surface soil and groundwater samples were also analyzed for PAHs.

<sup>b</sup> LOC - Level of Concern. Refers to either the WRF site background maximum concentrations for inorganics or USEPA Region III residential risk-based concentrations (RBCs) for organics.

**Table 7-13 (Continued)**  
**Inorganics Detected in Surface Soil Samples Collected in AREE 4**

Sample ID	Aluminum (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)
Site Background <sup>a</sup>	14,360	0.814	1,160	31.3	16.6
RISS13	8,240	0.454	167	12.8	3.81
RISS14	8,960	0.524	172	15.6	5.02
RISS15	8,640	0.407	210	17.0	3.64
RISS16	8,900	0.434	219	15.0	3.61

Sample ID	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background <sup>a</sup>	12.6	28,108	22.4	2,610	875
RISS13	4.04	10,500	22.5	669	99.2
RISS14	6.56	12,900	22.7	950	84.4
RISS15	4.11	14,700	15.9	684	134
RISS16	6.63	14,300	22.3	721	64.7

Sample ID	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	11.9	936	487	58.9	43.9
RISS13	4.94	547	475	23.1	20.1
RISS14	6.12	692	505	32.2	24.5
RISS15	4.74	542	462	30.8	20.8
RISS16	5.82	604	490	30.3	23.6

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for surface soil samples collected from MW-52 through MW-54 and RIBKSS1 through RIBKSS5.

**Table 7-13 (Continued)**  
**Organics Detected in Surface Soil Samples Collected in AREE 4**

Sample ID	Acenaphthene (µg/g)	Acetone (µg/g)	Anthracene (µg/g)	Benzo(a)anthracene (µg/g)	Benzo(a)pyrene (µg/g)
RBC <sup>a</sup>	470	780	2,300	0.88	0.088
RISS13	ND	ND	0.058	0.003	0.004
RISS14	ND	ND	0.034	0.006	0.009
RISS15	0.931	ND	0.014	0.003	0.005
RISS16	ND	0.020	0.055	0.004	0.006

Sample ID	Benzo(b)fluoranthene (µg/g)	Benzo(g,h,i)perylene (µg/g)	Benzo(k)fluoranthene (µg/g)	Chrysene (µg/g)	Fluoranthene (µg/g)
RBC <sup>a</sup>	0.88	230 <sup>b</sup>	8.8	88	310
RISS13	0.008	ND	0.004	0.025	0.058
RISS14	0.012	0.015	0.005	ND	0.017
RISS15	0.006	0.008	0.003	ND	0.009
RISS16	0.008	0.012	0.004	ND	0.015

Sample ID	Indeno(1,2,3-cd)-pyrene (µg/g)	Methylene chloride (µg/g)	Naphthalene (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)
RBC <sup>a</sup>	0.88	85	310	230 <sup>b</sup>	230
RISS13	ND	ND	0.314	0.054	0.032
RISS14	0.007	ND	ND	ND	0.019
RISS15	ND	ND	ND	ND	0.013
RISS16	0.004	0.010	ND	ND	0.013

ND Not detected.

<sup>a</sup> The soil and sediment RBC values are from USEPA Region III Residential Soil RBCs (USEPA 1996a). RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

<sup>b</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

**Table 7-13 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (0 to 2 ft bgs) Collected in AREE 4**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)
Site Background*	14,350	92.4	0.814	1,150	31.3	16.6
MW-64	12,500	ND	0.66	168	19.2	5.78
MW-65	9,820	ND	0.70	724	20.2	6.30
MW-65DUP	7,440	63.1	0.46	955	13.1	8.22
MW-66	11,500	50.7	0.43	142	19.3	5.86
MW-67	11,600	ND	0.61	148	19.2	4.78

Sample ID	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)
Site Background*	12.6	28,100	22.4	2,610	875	11.9
MW-64	10.3	19,900	11.3	1,630	65.5	8.80
MW-65	13.9	23,200	14.7	1,670	96.9	9.16
MW-65DUP	7.16	9,780	ND	1,190	97.6	8.29
MW-66	6.80	14,500	10.3	1,320	139	6.53
MW-67	8.68	18,800	16.7	1,180	65.0	6.61

Sample ID	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background*	936	14.2	487	58.9	43.9
MW-64	579	13.0	357	38.3	34.2
MW-65	705	ND	424	39.1	39.3
MW-65DUP	445	ND	503	24.3	21.9
MW-66	570	ND	470	32.7	31.7
MW-67	629	ND	406	38.4	29.4

ND Not detected.

\* Site background concentrations are based on WRF site background maximum concentrations for surface soil samples collected from MW-52 through MW-54.

**Table 7-13 (Continued)**  
**Organics Detected in Subsurface Soil Samples (0 to 2 ft bgs) Collected in AREE 4**

Sample ID	Benzo(a)pyrene (µg/g)	Bis(2-ethylhexyl)phthalate (µg/g)	Di-n-butyl phthalate (µg/g)
RBC <sup>a</sup>	0.088	46	780
MW-64	ND	ND	ND
MW-65	0.22	1.20	4.90
MW-65DUP	ND	2.40	4.20
MW-66	ND	ND	ND
MW-67	ND	ND	ND

ND Not detected.

<sup>a</sup> Soil RBC values are from Region III Residential Soil RBCs (USEPA 1996a). RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

**Table 7-13 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table) Collected in AREE 4**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background*		18,200	73.8	1.02	454	25.0
MW-64	15	11,800	86.5	0.93	1,200	31.9
	20	4,970	ND	ND	205	10.8
MW-65	10	6,990	55.4	0.71	409	12.6
	15	1,880	ND	0.27	280	5.74
MW-66	5	7,430	ND	0.35	129	12.1
	10	2,870	ND	ND	196	3.87
MW-67	5	7,510	ND	0.40	145	12.6
	10	4,580	ND	0.37	168	7.73

Sample ID	Depth bgs (ft)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)
Site Background*		13.9	16.8	27,800	11.8	3,700
MW-64	15	24.2	24.2	1,890	10.1	4,570
	20	4.42	4.47	3,130	ND	842
MW-65	10	4.58	12.2	7,840	ND	1,050
	15	ND	2.91	1,460	ND	448
MW-66	5	8.90	5.65	6,100	ND	955
	10	2.98	1.65	1,750	ND	322
MW-67	5	8.23	5.59	8,190	ND	1,030
	10	2.22	3.90	10,200	ND	383



**Table 7-13 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table) Collected in AREE 4**

Sample ID	Depth bgs (ft)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>		617	17.9	624	933	26.8	46.3
MW-64	15	141	21.3	994	720	55.5	46.5
	20	344	5.24	292	406	11.7	11.5
MW-65	10	24.4	4.84	252	424	20.8	14.0
	15	9.49	ND	138	358	6.73	ND
MW-66	5	396	7.17	335	386	22.6	13.8
	10	37.0	ND	143	414	4.72	7.76
MW-67	5	578	5.61	433	357	18.3	16.9
	10	156	2.41	170	378	14.7	10.3

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for subsurface soil samples MW-52 through MW-54, collected at two depths.

**Table 7-13 (Continued)**  
**Organics Detected in Subsurface Soil Samples (2 ft bgs to Water Table) Collected in AREE 4**

Sample ID RBC <sup>a</sup>	Depth bgs (ft)	Acetone (µg/g)	Bis(2- ethylhexyl)phthalate (µg/g)	Di-n-butyl phthalate (µg/g)
		780	46	780
MW-64	10	ND	ND	ND
	15	ND	ND	ND
MW-65	10	0.01	1.00	4.50
	15	ND	0.84	4.60
MW-66	10	ND	ND	ND
	15	ND	ND	ND
MW-67	10	ND	ND	ND
	15	ND	ND	ND

ND Not detected.

<sup>a</sup> The soil RBC values are from Region III Residential Soil RBCs (USEPA 1996a). RBCs for noncarcinogenic chemicals are based on hazard quotient of 0.1, following USEPA Region III guidance.

**Table 7-13 (Continued)**  
**Inorganics Detected in Test Pit Samples Collected in AREE 4**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background <sup>a</sup> (0-2ft)		14,350	92.4	0.814	1,150	31.3
Site Background <sup>a</sup> (2ft-water table)		18,200	73.8	1.82	454	25.0
TP-5A	5.75	8,840	ND	0.750	466	16.3
TP-5B	0.0	10,400	ND	0.507	290	21.2
TP-6A	5.6	16,800	53.3	1.25	237	31.1
TP-7A	0.0	13,900	ND	0.916	528	21.6
TP-7B	6.66	15,000	64.6	0.631	261	26.7
TP-8A	8.0	2,680	ND	ND	153	5.42
TP-8B	6.5	18,600	222	1.44	1,130	40.8
TP-9A	7.0	4,480	ND	ND	190	12.8
TP-9ADUP	7.0	5,470	ND	0.377	225	12.7
TP-9B	8.0	17,100	116	0.902	615	40.1
TP-10A	8.0	11,300	ND	0.750	265	18.1
TP-10B	0.0	15,100	ND	0.859	241	25.6
TP-11A	7.0	8,790	ND	0.237	505	26.8
TP-11B	0.0	14,700	103	1.30	421	29.1
TP-12A	0.0	15,900	ND	0.871	200	26.2
TP-12B	7.0	13,300	ND	1.37	572	31.6

**Table 7-13 (Continued)**  
**Inorganics Detected in Test Pit Samples Collected in AREE 4**

Sample ID	Depth bgs (ft)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)
Site Background* (0-2ft)		16.6	12.6	28,100	22.4	2,610
Site Background* (2ft-water table)		13.9	16.9	27,800	11.8	3,700
TP-5A	5.75	5.26	5.90	13,700	17.3	773
TP-5B	0.0	5.85	5.48	15,900	18.8	811
TP-6A	5.6	10.6	12.3	19,000	11.1	3,140
TP-7A	0.0	5.53	8.49	21,200	19.6	1,140
TP-7B	6.66	7.01	15.4	14,300	14.3	2,430
TP-8A	8.0	2.92	3.35	2,880	ND	459
TP-8B	6.5	15.3	27.8	17,600	12.4	5,250
TP-9A	7.0	6.47	5.53	5,350	ND	1,550
TP-9ADUP	7.0	6.19	5.34	6,210	ND	1,520
TP-9B	8.0	22.9	27.4	24,900	12.6	5,870
TP-10A	8.0	4.14	10.5	31,900	9.13	870
TP-10B	0.0	5.04	14.4	36,700	14.8	1,150
TP-11A	7.0	5.83	8.36	12,900	ND	3,330
TP-11B	0.0	29.0	100	31,500	13.4	3,770
TP-12A	0.0	6.76	11.4	31,200	15.4	1,470
TP-12B	7.0	8.19	22.0	11,900	14.8	3,230

**Table 7-13 (Continued)**  
**Inorganics Detected in Test Pit Samples Collected in AREE 4**

Sample ID	Depth bgs (ft)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup> (0-2ft)		875	11.8	936	487	58.9	43.8
Site Background <sup>a</sup> (2 ft-water table)		617	17.9	624	933	25.8	46.3
TP-5A	5.75	141	4.68	521	364	29.6	31.4
TP-5B	0.0	115	5.70	524	461	34.8	30.4
TP-6A	5.6	85.1	13.6	1,010	520	47.5	36.7
TP-7A	0.0	81.3	7.42	717	506	39.3	35.1
TP-7B	6.66	53.4	11.1	966	709	38.0	40.5
TP-8A	8.0	48	2.93	224	482	10.2	13.8
TP-8B	6.5	121	31.3	1,340	996	66.7	61.4
TP-9A	7.0	49.4	4.98	254	627	20	21.9
TP-9ADUP	7.0	50.7	6.65	279	669	20.9	22.4
TP-9B	8.0	124	29.8	1,030	1,540	64.9	73.0
TP-10A	8.0	46.6	5.47	586	442	30.7	27.0
TP-10B	0.0	38.8	6.16	751	278	49.1	29.6
TP-11A	7.0	89.8	12.3	952	523	28.3	37.2
TP-11B	0.0	182	19.2	733	700	49.5	49.2
TP-12A	0.0	134	8.69	765	436	50.4	34.8
TP-12B	7.0	60.6	14.8	815	772	62.3	57.6

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for surface (0-2 feet bgs) and subsurface soil (2 feet bgs to water table).

**Table 7-13 (Continued)**  
**Organics Detected in Test Pit Samples Collected in AREE 4**

Sample ID	Acetone (µg/g)	Bis(2- ethylhexyl)- phthalate (µg/g)	DDE (µg/g)	DDT (µg/g)	Diethyl Phthalate (µg/g)	Methoxychlor (µg/g)	Methylene Chloride (µg/g)
RBC <sup>a</sup>	780	46	1.9	1.9	6,300	39	85
TP-5A	ND	0.300	ND	ND	ND	ND	ND
TP-5B	ND	ND	0.006	0.004	ND	0.004	ND
TP-6A	ND	ND	ND	ND	ND	ND	ND
TP-6B	ND	ND	ND	ND	ND	ND	ND
TP-7A	ND	1.200	ND	ND	ND	ND	ND
TP-7B	0.010	ND	ND	ND	ND	ND	ND
TP-8A	0.020	ND	ND	ND	ND	ND	ND
TP-8B	ND	ND	ND	ND	ND	ND	ND
TP-9A	0.010	ND	ND	ND	ND	ND	ND
TP-9AD	0.010	ND	ND	ND	ND	ND	ND
TP-9B	0.020	ND	ND	ND	ND	ND	ND
TP-10A	ND	ND	ND	ND	ND	ND	ND
TP-10B	ND	ND	ND	ND	ND	ND	ND
TP-11A	ND	ND	ND	ND	ND	ND	0.010
TP-11B	ND	ND	ND	ND	ND	ND	0.020
TP-12A	ND	ND	ND	ND	ND	ND	0.020
TP-12B	ND	ND	ND	ND	ND	ND	0.020

ND Not detected.

<sup>a</sup> The soil RBC values are from USEPA Region III Residential Soil RBCs (USEPA, 1996a). RBC values for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

**Table 7-13 (Continued)**  
**Inorganics Detected in Groundwater Samples Collected in AREE 4**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Calcium (µg/L)	Chromium (µg/L)
Site Background <sup>a</sup>	12,500	6.70	107	42,200	22.3
MW-64	1,400	ND	50.5	7,110	ND
MW-64 Round 2 <sup>b</sup>	89.8	ND	37.0	4,930	ND
MW-65	57.6	ND	88.8	9,090	ND
MW-65 Round 2	40.2	ND	82.0	8,470	ND
MW-65DUP	83.9	ND	87.6	8,900	ND
MW-66	242	ND	38.6	5,760	10.7
MW-66 Round 2	336	ND	38.6	5,030	ND
MW-67	689	3.1	76.4	3,300	ND
MW-67 Round 2	95.0	3.6	63.3	3,050	ND

Sample ID	Cobalt (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)
Site Background <sup>a</sup>	ND	9,620	6.3	7,720	354
MW-64	ND	1,910	2.00	4,240	490
MW-64 Round 2	ND	143	ND	3,570	117
MW-65	ND	261	ND	9,660	115
MW-65 Round 2	ND	330	ND	8,870	63.5
MW-65DUP	ND	304	ND	9,460	112
MW-66	ND	290	ND	4,680	276
MW-66 Round 2	ND	528	ND	4,800	391
MW-67	32.3	10,500	ND	4,230	4,670
MW-67 Round 2	24.3	8,070	ND	3,920	3,730

**Table 7-13 (Continued)**  
**Inorganics Detected in Groundwater Samples Collected in AREE 4**

Sample ID	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Sodium (µg/L)	Zinc (µg/L)
Site Background <sup>a</sup>	18.4	20,600	4.2	43,500	46.0
MW-64	16.6	2,690	2.9	16,400	31.1
MW-64 Round 2	ND	1,070	ND	15,700	105
MW-65	ND	1,320	5.6	38,800	28.2
MW-65 Round 2	ND	1,210	3.1	37,400	ND
MW-65DUP	ND	1,220	5.7	38,100	35.5
MW-66	ND	780	3.4	29,600	38.6
MW-66 Round 2	ND	1,020	2.1	26,400	ND
MW-67	ND	1,290	ND	21,400	27.3
MW-67 Round 2	ND	1,450	ND	20,400	26.1

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for groundwater samples.

<sup>b</sup> Round 2 sampling was conducted in March 1996.



**Table 7-13 (Continued)**  
**Organics Detected in Groundwater Samples Collected from AREE 4**

Sample ID	Bis(2-ethylhexyl) phthalate
RBC <sup>a</sup>	4.8
MW-64	ND
MW-65	ND
MW-65DUP	2.2
MW-66	ND
MW-67	ND

ND Not detected.

<sup>a</sup> Groundwater RBC values are from USEPA Region III Tap Water RBCs. RBCs for noncarcinogenic chemicals are based on hazard quotient of 0.1, following USEPA Region III guidance.

**Table 7-13 (Continued)**  
**Inorganics Detected In Surface Water Runoff Samples Collected In AREE 4**

Sample ID	Aluminum (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)
SWR06	9,780	78.2	0.2	4,480	14.0	ND
SWR07	7,010	138	0.5	6,160	11.5	21.6

Sample ID	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)
SWR06	7.1	10,900	15.9	2,760	187	ND	3,280
SWR07	9.8	12,300	25.4	5,520	321	19.3	2,620

Sample ID	Selenium (µg/L)	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
SWR06	ND	2,540	0.1	30.0	42.5
SWR07	2.3	13,600	0.1	27.4	112

ND      Not detected.

**Table 7-13 (Continued)**  
**Organics Detected In Surface Water Runoff Samples Collected In AREE 4**

Sample ID	Anthracene (µg/L)	DDD,pp' (µg/L)	DDT,pp' (µg/L)	Fluoranthene (µg/L)	Pyrene (µg/L)
SWR06	0.485	ND	ND	0.029	ND
SWR07	3.80	0.010	0.009	0.044	0.214

ND Not detected.

**Table 7-14**  
**Summary of RI Results for AREE 6B - Potential Dump No. 6B**

Media Sampled <sup>a</sup>	Number of Samples Collected	Compounds/Analytes Detected above LOC <sup>b</sup>	Summary of Fate & Transport
Surface Soil	1	K	Infiltration/percolation through soil to groundwater  Stormwater runoff to surface water/sediment
Subsurface Soil (0- to 2-ft bgs)	2	None	
Subsurface Soil (2-ft bgs to Water Table)	5	Ca, Co, V	
Test Pits	6	Al, Ba, Ca, Cr, Cu, Fe, Pb, Mg, Ni, K, Na, V	
Groundwater - Round 1	3	heptachlor epoxide	Discharge to surface water
Groundwater - Round 1	3	None	

<sup>a</sup> Surface soil, subsurface soil, and groundwater samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH. If PCBs were detected, the laboratory was instructed to analyze for PCTs. Surface soil samples were also analyzed for PAHs.

<sup>b</sup> LOC - Level of Concern. Refers to either the WRF site background maximum concentrations for inorganics or the USEPA Region III residential risk-based concentrations (RBCs) for organics.

**Table 7-14 (Continued)**  
**Inorganics Detected in Surface Soil Sample Collected in AREE 6B**

Sample ID	Aluminum (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background <sup>a</sup>	14,350	3.8	92.4	0.814	1,150	31.3
RISS24	15,400	0.643	55.9	0.857	211	27.7

Sample ID	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background <sup>a</sup>	16.6	12.6	28,100	22.4	2,610	875
RISS24	7.99	15.5	37,300	15.1	1350	40.2

Sample ID	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	11.9	936	14.2	487	58.9	43.9
RISS24	7.98	692	17.8	448	52.3	32.0

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF maximum site background concentrations for surface soil samples from MW-52 through MW-54 and RISSBK1 through RISSBK5.

**Table 7-14 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (0 to 2 ft bgs) Collected in AREE 6B**

Sample ID	Aluminum (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)
Site Background <sup>a</sup>	14,350	0.814	1,150	31.3	16.6	12.6	28,100	22.4
MW-60	9,580	0.388	755	16.6	ND	9.17	24,700	13.4
MW-75	5,760	0.755	716	14.9	6.04	9.98	14,800	16.9

Sample ID	Magnesium (µg/g)	Manganese (µg/g)	Mercury (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	2,610	875	ND	11.9	936	487	58.9	43.9
MW-60	674	22	ND	3.1	313	440	41.8	15.6
MW-75	1,440	106	ND	6.36	482	463	30.2	24.2

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF maximum site background concentrations for surface soils collected from MW-52 through MW-54 and RISSBK1 through RISSBK5.

**Table 7-14 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table) Collected in AREE 6B**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)
Site Background <sup>a</sup>		18,200	73.8	1.02	454	25.0	13.9	16.9	27,800
MW-60	20	5,840	54.5	0.429	1,150	21.9	7.06	14.2	23,600
	35	1,660	ND	0.618	403	3.85	61.0	6.85	15,200
MW-75	5	4,300	ND	0.427	700	11.8	5.06	4.58	14,900
	15	2,030	ND	ND	144	4.77	ND	2.43	1,750
MW-75DUP	5	3,560	ND	0.599	678	10.6	3.16	4.20	10,300

Sample ID	Depth bgs (ft)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>		11.8	3,700	617	17.9	624	933	25.8	46.3
MW-60	20	ND	3,090	112	11	546	639	38.4	28.8
	35	ND	600	1,020	6.5	289	424	13.5	15.7
MW-75	5	9.68	706	87.4	3.53	271	525	22.4	11.9
	15	ND	431	12.6	ND	183	454	7.16	6.41
MW-75DUP	5	ND	634	82.4	3.32	243	547	20.9	10.7

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF maximum site background concentrations for subsurface soils collected from MW-52 through MW-54, at 2 depths.

**Table 7-14 (Continued)**  
**Organics Detected in Subsurface Soil Samples (2 ft bgs to Water Table) Collected in AREE 6B**

Sample ID	Depth bgs (ft)	Acetone (µg/g)	Benzo(a)pyrene (µg/g)	Bis(2-ethylhexyl) phthalate (µg/g)	DDT (µg/g)
RBC <sup>a</sup>		780	0.088	48	1.9
MW-60	20	ND	ND	ND	ND
	35	ND	ND	ND	ND
MW-75	5	0.08	ND	ND	ND
	15	0.02	0.24	0.23	ND
MW-75DUP	5	ND	ND	ND	0.01

ND Not detected.

<sup>a</sup> Soil RBC values are from USEPA Region III Residential Soil RBCs. RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.



**Table 7-14 (Continued)**  
**Inorganics Detected in Test Pit Samples Collected in AREE 6B**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background* (0 ft bgs)		14,350	92.4	0.814	1,150	31.3
Site Background* (2 ft bgs)		18,200	73.8	1.02	454	25.0
TP-18A	6.6	5,450	ND	ND	179	7.03
TP-18B	0.0	10,800	ND	0.369	210	19.4
TP-19A	8.3	6,810	ND	ND	198	9.48
TP-19B	0.0	11,000	54.4	0.430	1,280	20.8
TP-20A	5.0	12,900	74.0	0.510	1,100	28.9
TP-20B	0.0	16,200	ND	0.731	500	27.3

Sample ID	Depth bgs (ft)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)
Site Background* (0 ft bgs)		16.6	12.6	14,350	22.4	2,610
Site Background* (2 ft bgs)		13.9	16.9	28,100	11.8	3,700
TP-18A	6.6	ND	2.60	2,040	ND	484
TP-18B	0	5.19	9.98	19,300	19.2	1,380
TP-19A	8.3	2.71	4.23	4,700	ND	789
TP-19B	0	7.75	9.35	20,500	17.6	1,750
TP-20A	5	13.3	15.0	18,000	10.9	4,240
TP-20B	0	6.58	14.3	24,300	15.5	2,550

**Table 7-14 (Continued)**  
**Inorganics Detected in Test Pit Samples Collected in AREE 6B**

Sample ID	Depth bgs (ft)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup> (0 ft bgs)		875	11.9	936	487	58.9	43.9
Site Background <sup>a</sup> (2 ft bgs)		617	17.9	624	933	25.8	46.3
TP-18A	6.6	14.7	3.29	326	331	8.26	8.62
TP-18B	0	93.9	6.40	809	384	37.9	29.2
TP-19A	8.3	22.3	3.45	384	458	16.0	14.3
TP-19B	0	140	9.00	716	450	38.8	35.6
TP-20A	5	205	19.0	1,190	929	40.4	38.5
TP-20B	0	83.7	10.6	1,090	650	48.8	34.3

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF site background maximum concentrations for surface (0-2 ft. bgs) and subsurface (2 ft. bgs - water table) soils.

**Table 7-14 (Continued)**  
**Organics Detected in Test Pit Samples Collected in AREE 6B**

Sample ID	Depth bgs (ft)	Acetone (µg/g)	Bis(2-ethylhexyl)-phthalate (µg/g)	DDT (µg/g)	Methoxychlor (µg/g)
RBC <sup>a</sup>		780	46	1.8	39
TP-18A	6.6	0.020	3.50	ND	ND
TP-18B	0	ND	ND	ND	0.004
TP-19A	8.3	0.020	0.220	ND	ND
TP-19B	0	ND	0.220	ND	ND
TP-20A	5	ND	3.20	ND	ND
TP-20B	0	ND	ND	0.006	ND

ND Not detected.

<sup>a</sup> USEPA Region III residential risk-based concentration (RBC) values. RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.

**Table 7-14 (Continued)**  
**Inorganics Detected in Groundwater Samples Collected in AREE 6B**

Sample ID	Aluminum (µg/L)	Barium (µg/L)	Calcium (µg/L)	Iron (µg/L)	Magnesium (µg/L)
Site Background <sup>a</sup>	12,500	107	42,200	9,620	7,720
MW-60	2,620	27.5	5,290	3,470	4,960
MW-60 Round 2	918	ND	4,170	3,340	3,660
MW-75	47.3	ND	4,450	1,440	2,940
MW-75 Round 2	133	ND	3,250	2,770	2,910
MW-75DUP	55.5	ND	4,390	1,420	2,900
MW-75DUP Round 2	NS	NS	NS	NS	NS

Sample ID	Manganese (µg/L)	Potassium (µg/L)	Sodium (µg/L)	Zinc (µg/L)
Site Background <sup>a</sup>	354	20,600	43,500	46.0
MW-60	281	1,560	13,200	ND
MW-60 Round 2	215	733	8,860	ND
MW-75	139	997	10,400	22.9
MW-75 Round 2	117	1,200	9,440	ND
MW-75DUP	138	1,060	10,200	ND
MW-75DUP Round 2	NS	NS	NS	NS

ND Not detected.

NS Not sampled

<sup>a</sup> Site background concentrations are based on WRF maximum site background concentrations in groundwater.

**Table 7-14 (Continued)**  
**Organics Detected in Groundwater Samples Collected in AREE 6B**

Sample ID	2-Methyl Naphthalene (µg/L)	Acetone (µg/L)	Bis(2- ethylhexyl)phthalate (µg/L)	DDE (µg/L)	DDT (µg/L)
RBC <sup>a</sup>	110 <sup>b</sup>	370	4.8	0.20	0.20
MW-60	2.48	16	3.6	0.024	0.019
MW-60 Round 2	ND	ND	ND	ND	ND
MW-75	ND	ND	2.3	ND	ND
MW-75 Round 2	ND	ND	32	ND	ND
MW-75DUP	ND	ND	3.2	ND	ND
MW-75DUP Round 2	NS	NS	NS	NS	NS

Sample ID	Endosulfan Sulfate (µg/L)	Endosulfan II (µg/L)	Fluoranthene (µg/L)	Gamma-Chlordane (µg/L)	Heptachlor Epoxide (µg/L)
RBC <sup>a</sup>	22 <sup>c</sup>	22 <sup>c</sup>	150	0.052	0.0012
MW-60	0.027	0.021	0.034	0.008	0.088
MW-60 Round 2	ND	ND	ND	ND	ND
MW-75	ND	ND	ND	ND	ND
MW-75 Round 2	ND	ND	ND	ND	ND
MW-75DUP	ND	ND	ND	ND	ND
MW-75DUP Round 2	NS	NS	NS	NS	NS

ND Not detected.

NS Not sampled

<sup>a</sup> Groundwater and surface water RBC values are from USEPA Region III Tap Water RBCs. RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region guidance.

<sup>b</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>c</sup> The RBC for endosulfan was used.

**Table 7-15**  
**Summary of Preliminary RI Results for AREE 7 - Former Pistol Range**

Media Sampled <sup>a</sup>	Number of Samples Collected	Compounds/Analytes Detected above LOC <sup>b</sup>	Summary of Fate & Transport
Surface Soil	1	Al, Be, Cu, Fe, Se	Infiltration/percolation through soil to groundwater  Stormwater runoff to surface water/sediment
Subsurface Soil (0- to 2-feet bgs)	1	None	
Subsurface Soil (2-feet bgs to Water Table)	2	None	
Groundwater	Round 1 - 1 Round 2 - 1	None	Discharge to surface water

<sup>a</sup> Surface soil samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and TPH. If PCBs were detected, the laboratory was instructed to analyze for PCTs. Subsurface soil samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PCTs, and TPH. Groundwater samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, PCTs, and TPH.

<sup>b</sup> LOC - Level of Concern. Refers to either the WRF site background maximum concentrations for inorganics or USEPA Region III residential risk-based concentrations (RBCs) for organics.

**Table 7-15 (Continued)**  
**Inorganics Detected in Surface Soil Samples Collected in AREE 7**

Sample ID	Aluminum (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)
Site Background <sup>a</sup>	14,350	0.814	1,150	31.3	16.6
RISS25	13,500	0.739	191	22.1	5.47

Sample ID	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background <sup>a</sup>	12.6	28,100	22.4	2,610	875
RISS25	11.1	22,900	14.7	1,570	87.2

Sample ID	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	11.9	936	14.2	487	58.9	43.9
RISS25	8.92	1,110	14.1	481	39.5	33.6

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF maximum site background concentrations for surface soil samples collected from MW-52 through MW-54 and RISSBK1 through RISSBK5.

**Table 7-15 (Continued)**  
**Organics Detected in Surface Soil Samples Collected in AREE 7**

Sample ID	Benzo(a)pyrene (µg/g)	Benzo(b)fluoranthene (µg/g)	Benzo(k)fluoranthene (µg/g)	Fluoranthene (µg/g)
RBC*	0.088	0.88	8.8	310
RISS25	0.002	0.002	0.001	0.003

\* USEPA Region III residential risk-based concentration (RBC) values. RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.



**Table 7-15 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (0 to 2 ft bgs) Collected in AREE 7**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)
Site Background <sup>a</sup>	14,350	92.4	0.814	1,150	31.3	16.6	12.6	28,100
MW-59	11,900	52.5	0.65	437.00	20.80	7.43	12.1	18,200

Sample ID	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	22.4	2,610	875	11.9	936	487	58.9	43.9
MW-59	12.0	1,730	98.9	9.05	599	374	36.8	32.5

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF maximum site background concentrations for surface soils collected from MW-52 through MW-54 and RISSBK1 through RISSBK5.

**Table 7-15 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft bgs to Water Table) Collected in AREE 7**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)
Site Background <sup>a</sup>		18,200	454	25.0	13.9	16.9
MW-59	25	1,030	ND	3.62	ND	2.50
	29	2,700	290	8.97	2.66	5.22

Sample ID	Depth bgs (ft)	Iron	Magnesium	Manganese	Nickel	Potassium
Site Background <sup>a</sup>		27,800	3,700	617	17.9	624
MW-59	25	1,160	200	9.59	ND	125
	29	3,530	790	25.5	4.21	217

Sample ID	Depth bgs (ft)	Sodium	Vanadium	Zinc
Site Background <sup>a</sup>		933	25.8	46.3
MW-59	25	256	4.82	ND
	29	370	9.12	11.2

ND Not detected.

<sup>a</sup> Site background concentrations are based on WRF maximum site background concentrations for subsurface soils collected from samples from MW-52 through MW-54.

**Table 7-15 (Continued)**  
**Inorganics Detected in Groundwater Samples Collected in AREE 7**

Sample ID	Aluminum (µg/L)	Barium (µg/L)	Calcium (µg/L)	Iron (µg/L)
Site Background <sup>a</sup>	12,500	107	42,200	9,620
MW-59	483	25.4	3,370	346
MW-59 Round 2	185	30.7	4,190	180

Sample ID	Magnesium (µg/L)	Manganese (µg/L)	Potassium (µg/L)	Sodium (µg/L)
Site Background <sup>a</sup>	7,720	354	20,600	43,500
MW-59	2,410	54.1	947	8,070
MW-59 Round 2	2,480	65.7	1,010	8,300

<sup>a</sup> Site background concentrations are based on WRF maximum site background concentrations in groundwater.

**Table 7-16**  
**Inorganics Detected in Shallow Soil Samples (0 to 2 ft bgs)**  
**Collected in the the Main Compound**

Sample ID	Aluminum (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background <sup>a</sup>	18,200	--	73.8	1.02	454	25.0
MW-61	7,610	ND	67.7	0.72	1,010	18.4
RISB-1	7,720	ND	ND	0.33	441	14.2
RISB-2	13,300	2.63	56.3	0.49	1,040	20.2

Sample ID	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background <sup>a</sup>	13.9	16.9	27,800	11.8	3,700	617
MW-61	8.49	6.27	16,300	15.0	1,180	721
RISB-1	4.65	5.48	11,400	ND	727	206
RISB-2	6.07	7.77	17,300	9.08	1,530	203

Sample ID	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	17.9	624	--	933	25.9	46.3
MW-61	6.33	755	ND	403	33.4	22.5
RISB-1	4.32	308	ND	378	24.1	13.7
RISB-2	8.21	529	11.6	404	35.3	24.9

-- No value available.

ND Not detected.

a Site Background concentrations are based on WRF site background maximum concentrations for samples collected from soil samples MW-52 through MW-54, and soil samples RIBKSS1 through RIBKSS5.

**Table 7-17**  
**Organics Detected in Shallow Soil Samples (0 to 2 ft bgs)**  
**Collected in the the Main Compound**

Sample ID	2-Methyl-naphthalene (µg/g)	Acetone (µg/g)	Bis(2-ethyl-hexyl) phthalate (µg/g)	DDE (µg/g)	DDT (µg/g)	Naphthalene (µg/g)	PCB-1260 (µg/g)	TPH as Diesel (µg/g)
RBC	230 <sup>a</sup>	720	46	1.9	1.9	310	0.083 <sup>b</sup>	100 <sup>c</sup>
MW-61	ND	ND	ND	ND	ND	ND	ND	ND
RISB-1	1.40	0.02	ND	ND	ND	4.90	0.02	49.0
RISB-2	ND	0.02	ND	ND	ND	ND	ND	33.0

<sup>a</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>b</sup> Value is for carcinogenic PCBs.

<sup>c</sup> VDEQ action level.

-- No value available.

ND Not detected.

RBC USEPA Region III residential risk-based concentration (RBC) values.

**Table 7-18**  
**Inorganics Detected in Subsurface Soil Samples (2 ft to Water Table)**  
**Collected in the the Main Compound**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background <sup>a</sup>		18,200	ND	73.8	1.02	454	25.0
MW-61	5	16,300	ND	57.6	0.64	582	21.1
	15	1,200	ND	ND	ND	ND	3.76
RISB-1	5	13,700	0.76	45.4	0.66	329	20.5
	10	7,420	ND	ND	0.36	280	12.2
RISB-1Dup	5	16,400	1.22	49.2	0.69	288	24.0
RISB-2	5	15,200	1.45	53.7	0.67	561	22.3
	10	5,830	ND	ND	0.37	141	8.47

Sample ID	Depth (ft)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background <sup>a</sup>		13.9	18.9	27,800	11.8	3,700	617
MW-61	5	9.54	10.4	21,700	11.1	2,440	302.0
	15	ND	1.39	2,430	ND	157	46.6
RISB-1	5	7.07	8.84	18,300	8.92	2,360	188.0
	10	11.0	5.57	11,100	ND	1,080	207.0
RISB-1Dup	5	8.19	10.9	21,800	ND	2,830	223.0
RISB-2	5	11.0	9.13	19,100	ND	1,890	168.0
	10	4.23	3.76	8,290	ND	729	135.0

Sample ID	Depth bgs (ft)	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>		17.9	624	ND	433	25.8	46.3
MW-61	5	9.51	1,680	ND	479	48.1	28.8
	15	ND	ND	ND	310	3.52	ND
RISB-1	5	8.57	403	15.0	413	40.6	27.4
	10	4.66	288	ND	366	22.6	14.0
RISB-1Dup	5	10.0	490	18.4	402	50.4	30.6
RISB-2	5	9.54	514	14.4	428	46.5	27.2
	10	3.94	247	ND	421	17.1	11.4

-- No value available.

ND Not detected.

a Site background concentrations are based on WRF maximum site background concentrations for subsurface soils collected from MW-52 through MW-54, at two depths (greater than 2 feet bgs).

**Table 7-19**  
**Organics Detected in Subsurface Soil Samples (2 ft to Water Table)**  
**Collected in the the Main Compound**

Sample ID	Depth bgs (ft)	2-Methyl-naphthalene (µg/g)	Acetone (µg/g)	Bis(2-ethylhexyl)-phthalate (µg/g)	Naphthalene (µg/g)	PCB-1260 (µg/g)	Phenanthrene (µg/g)
RBC		230 <sup>a</sup>	780	46	310	0.083 <sup>b</sup>	--
MW-61	15	ND	ND	ND	ND	ND	ND
RISB-1	5	ND	ND	ND	ND	0.04	ND
	10	1.40	ND	ND	3.20	0.30	0.95
RISB-1DUP	5	ND	ND	ND	ND	0.03	ND
RISB-2	5	ND	0.02	ND	ND	ND	ND
	10	ND	ND	ND	ND	ND	ND

<sup>a</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>b</sup> Value is for carcinogenic PCBs.

ND Not Detected.

-- No value available.

RBC USEPA Region III risk-based concentration (RBC) values.

**Table 7-20**  
**Inorganics Detected in Groundwater Samples Collected in the Main Compound**

Sample ID	Aluminum µg/L	Arsenic µg/L	Barium µg/L	Cadmium µg/L	Calcium µg/L	Iron µg/L	Lead µg/L
Site Background	12,500	6.70	107	0.8	42,200	9,620	6.3
RBC	3,700	0.045	260	1.8	--	1,100	--
Round 1							
MW-33	138	ND	ND	ND	14,200	6,880	ND
MW-34	184	ND	32.8	ND	4,790	168	4.2
MW-35	61.9	ND	42.9	0.1	22,300	69.6	ND
MW-37	103	ND	34.3	ND	4,510	130	ND
MW-38	190	ND	31.2	ND	3,950	508	ND
MW-39	86.1	ND	28.2	ND	3,040	199	2.8
MW-39Dup	106	ND	28.6	0.1	3,120	264	2.8
MW-61	172	ND	34.9	0.3	7,230	314	ND
Round 2							
MW-61	3,620	ND	41.9	0.2	7,160	2,410	ND

Sample ID	Magnesium µg/L	Manganese µg/L	Potassium µg/L	Selenium µg/L	Sodium µg/L	Zinc µg/L
Site Background	7,720	354	20,600	4.2	43,500	46
RBC	--	18	--	18	--	1,100
Round 1						
MW-33	6,270	453	1,300	ND	11,100	22.1
MW-34	3,410	70.9	881	ND	8,300	32.9
MW-35	9,530	115	2,200	ND	14,200	36.9
MW-37	4,610	261	673	ND	15,100	ND
MW-38	4,270	244	576	ND	15,200	ND
MW-39	3,560	115	1,280	ND	4,370	205
MW-39Dup	3,660	130	1,360	ND	4,410	226
MW-61	6,93	242	2,610	2.6	10,200	23.5
Round 2						
MW-61	7,270	229	4,210	2.3	9,110	ND

-- No value available.

ND Not detected.

RBC USEPA Region III residential risk-based concentration (RBC) values.



**Table 7-21**  
**Organics Detected in Groundwater Samples Collected in the Main Compound**

Sample ID	1-Methyl naphthalene (µg/L)	2-Methyl naphthalene (µg/L)	Acenaphthene (µg/L)	Acenaphthylene (µg/L)	Acetone (µg/L)	Anthracene (µg/L)
RBC	110 <sup>a</sup>	110 <sup>a</sup>	220	110 <sup>a</sup>	370	1,100
Round 1						
MW-33	ND	4.79	ND	2.35	ND	ND
MW-34	ND	ND	ND	ND	ND	ND
MW-35	ND	ND	ND	ND	ND	ND
MW-37	5.89	ND	11.3	7.38	ND	ND
MW-38	11.8	3.67	27.9	16.2	ND	ND
MW-39	ND	ND	ND	ND	ND	ND
MW-39-Dup	ND	ND	ND	ND	ND	ND
MW-61	ND	ND	ND	ND	ND	ND
Round 2						
MW-61	ND	ND	ND	ND	ND	ND

Sample ID	Bis(2-ethylhexyl) Phthalate (µg/L)	Chloroform (µg/L)	Dieldrin (µg/L)	Endosulfan sulfate (µg/L)	Ethylbenzene (µg/L)	Fluoranthene (µg/L)
RBC	4.8	0.15	0.0042	22 <sup>b</sup>	130	150
Round 1						
MW-33	2.6	ND	ND	ND	ND	0.023
MW-34	2.7	ND	ND	ND	ND	ND
MW-35	2.1	ND	ND	ND	ND	ND
MW-37	2.8	2.7	ND	ND	ND	ND
MW-38	ND	ND	ND	ND	2.7	ND
MW-39	7.2	ND	ND	ND	ND	ND
MW-39Dup	10	ND	ND	ND	ND	ND
MW-61	3.3	ND	ND	ND	ND	ND
Round 2						
MW-61	ND	ND	ND	ND	ND	ND

**Table 7-21 (continued)**  
**Organics Detected in Groundwater Samples Collected in the Main Compound**

Sample ID	Fluorene (µg/L)	Naphthalene (µg/L)	Phenanthracene (µg/L)	Phenanthrene (µg/L)	Pyrene (µg/L)
RBC	--	--	110 <sup>a</sup>		110
Round 1					
MW-33	0.801	3.28	ND	ND	ND
MW-34	ND	ND	ND	ND	ND
MW-35	ND	ND	ND	ND	ND
MW-37	ND	23.3	ND	ND	ND
MW-38	1.18	32.4	ND	ND	ND
MW-39	ND	ND	ND	ND	ND
MW-39Dup	ND	ND	ND	ND	ND
MW-61	ND	ND	ND	ND	ND
Round 2					
MW-61	ND	ND	ND	ND	ND

<sup>a</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>b</sup> The RBC for endosulfan was used.

-- No value available.

ND Not detected.

RBC USEPA Region III residential risk-based concentration (RBC) values.

**Table 7-22**  
**Inorganics Detected in Groundwater Samples Collected in AREE 14**

Sample ID	Aluminum µg/L	Calcium µg/L	Iron µg/L	Magnesium µg/L	Manganese µg/L	Potassium µg/L	Sodium µg/L
Site Background	12,500	42,200	9,620	7,720	354	20,600	43,500
RBC	3,700	—	1,100	—	18	—	—
MW-41	105	7,980	81.9	3,780	111	2,270	2,100

RBC USEPA Region III residential risk-based concentration (RBC) value.

— No value available.

ND Not detected.

**Table 7-23**  
**Dioxins Detected in Surface Soil Samples Collected from AREE 20 and Background Samples**

Sample ID	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin µg/g	1,2,3,4,6,7,8-Heptachlorodibenzofuran µg/g
RBC	0.00004	0.00004
20SS0101	0.000099	0.000012
20SS0101Dup	0.000098	0.000012
20SS0201	0.000041	ND
20SS0301	ND	ND
20SS0401	0.000035	ND
RISSBK-3	0.000032	ND
RISSBK-4	0.000061	ND
RISSBK-5	0.000048	ND

Sample ID	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin µg/g	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin µg/g
RBC	0.000004	0.000004
20SS0101	0.0000031	0.0000031
20SS0101Dup	0.0000032	0.0000034
20SS0201	ND	ND
20SS0301	ND	ND
20SS0401	ND	ND
RISSBK-3	ND	ND
RISSBK-4	ND	ND
RISSBK-5	ND	ND

Sample ID	2,3,7,8-Tetrachlorodibenzofuran µg/g	Octachlorodibenzo-p-dioxin µg/g
RBC	0.000004	0.004
20SS0101	0.0000007	0.0043
20SS0101Dup	ND	0.0047
20SS0201	ND	0.0046
20SS0301	ND	0.0053
20SS0401	ND	0.0019
RISSBK-3	ND	0.0025
RISSBK-4	ND	0.0074
RISSBK-5	ND	0.0048

**Table 7-23 (continued)**  
**Dioxins Detected in Surface Soil Samples Collected from AREE 20 and Background Samples**

Sample ID	Octachlorodibenzofuran µg /g
<b>RBC</b>	<b>0.004</b>
20SS0101	0.000052
20SS0101Dup	0.000046
20SS0201	0.0000078
20SS0301	0.0000077
20SS0401	0.0000071
RISSBK-3	ND
RISSBK-4	ND
RISSBK-5	ND

ND Not detected.

RBC USEPA Region III residential risk-based concentration (RBC) values.

**Table 7-24**  
**Inorganics Detected in Surface Soil Samples Collected in AREE 40**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Cadmium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background <sup>a</sup>	14,350	92.4	0.814	ND	1,150	31.3
RISS60	8,360	72.8	0.693	0.689	504	13.6
RISS60Dup	7,920	74.3	0.739	0.791	512	13
RISS61	7,560	75.6	0.864	ND	478	13.5
RISS62	6,880	69.2	0.805	0.572	725	14.8
RISS63	5,930	59.8	0.795	ND	450	13.1

Sample ID	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background <sup>a</sup>	16.6	12.6	28,100	22.4	2,610	876
RISS60	8.46	4.56	11,000	88.6	968	796
RISS60Dup	9.31	4.46	11,200	111	900	819
RISS61	11.9	5.15	12,200	133	884	1,200
RISS62	9.43	6.64	10,700	176	807	806
RISS63	9.16	5.24	10,700	113	731	691

Sample ID	Mercury (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	ND	11.9	936	487	58.9	43.9
RISS60	0.151	5.75	355	428	23.4	214
RISS60Dup	ND	5.55	342	423	23.7	221
RISS61	ND	5.34	348	419	25.6	134
RISS62	ND	5.54	257	398	24.2	129
RISS63	0.129	4.23	261	417	24.1	97.3

— No value available.

ND Not Detected.

a Site background concentrations are based on WRF site background maximum concentrations for surface soil samples MW-52 through MW-54 and RIBKSS1 through RIBKSS5.

Table 7-25

## Inorganics Detected in Surface Soil Samples Collected in AREEs 11 and 17 North of the Main Compound

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)
Site Background	14,360	92.4	0.814	1,160	31.3	16.6
RISS-51	7,180	98.0	0.684	777	10.1	9.77
RISS-52	8,940	95.4	0.786	693	11.9	7.47
RISS-53	5,610	57.6	0.387	339	8.74	4.94

Sample ID	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)
Site Background	12.6	28,100	22.4	2,610	875	11.9
RISS-51	10.2	12,400	15.8	894	756	5.51
RISS-52	8.10	12,700	15.5	1,140	531	6.67
RISS-53	7.88	6,680	15.6	591	438	3.83

Sample ID	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background	936	487	58.9	43.9
RISS-51	309	450	26.1	49.2
RISS-52	359	394	30.4	49.4
RISS-53	257	426	20.0	36.0

-- No value available.

ND Not Detected.

a Site background concentrations are based on WRF site background maximum concentrations for surface soil samples MW-52 through MW-54 and RIBKSS1 through RIBKSS5.

**Table 7-25 (Continued)**

**Organics Detected in Surface Soil Samples Collected in AREEs 11 and 17 North of the Main Compound**

Sample ID	1-Methyl-naphthalene (µg/g)	Anthracene (µg/g)	Benzo(a)-anthracene (µg/g)	Benzo(a)-pyrene (µg/g)	Benzo(b)-fluoranthene (µg/g)	Benzo(g,h,i)-perylene (µg/g)
RBC	230 <sup>a</sup>	2,300	0.88	0.088	0.88	230 <sup>a</sup>
RISS-51	11.2	0.068	0.008	0.012	0.04	0.024
RISS-52	ND	0.014	0.002	0.007	0.014	0.014
RISS-53	ND	ND	0.004	0.006	0.017	0.017

Sample ID	Benzo(k)-fluoranthene (µg/g)	Chrysene (µg/g)	Fluoranthene (µg/g)	Indeno(1,2,3-cd)pyrene (µg/g)	PCB-1260 (µg/g)	Pyrene (µg/g)
RBC	8.8	88	310	0.88	0.083 <sup>b</sup>	230
RISS-51	0.021	0.052	0.068	0.022	0.04	0.041
RISS-52	0.006	ND	0.013	0.023	0.123	0.020
RISS-53	0.008	0.014	0.024	0.024	0.149	0.033

<sup>a</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>b</sup> Value is for carcinogenic PCBs.

ND Not detected.

RBC USEPA Region III residential risk-based concentration (RBC) values.



**Table 7-25 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (0 to 2 ft bgs)**  
**Collected in AREEs 11 and 17 North of the Main Compound**

Sample ID	Aluminum (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background <sup>a</sup>	18,200	--	73.8	1.02	454	25.0
MW-55	10,600	ND	57.0	0.50	545	16.4
MW-56	9,000	1.55	89.6	0.67	733	12.1
MW-57	7,300	ND	86.6	0.98	674	11.4
MW-58	8,980	ND	62.8	0.55	427	13.7
MW-85	8,080	ND	52.7	0.471	1,440	14.5
RISB-3	10,900	1.90	48.1	0.63	851	20.2
RISB-4	8,480	ND	ND	0.29	973	15.9
RISB-5	8,220	ND	64.5	0.41	370	11.5

Sample ID	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background <sup>a</sup>	13.9	16.9	27,800	11.8	3,700	617
MW-55	5.70	10.6	14,800	26.8	955	312
MW-56	10.9	6.14	13,200	11.3	997	540
MW-57	7.10	8.07	12,700	20.3	935	300
MW-58	8.85	8.34	11,100	ND	1,090	788
MW-85	7.45	28.6	14,300	25.3	1,620	346
RISB-3	10.60	9.73	16,500	26.7	1,460	416
RISB-4	3.42	15.9	12,400	ND	1,240	115
RISB-5	4.54	6.34	7,640	11.3	721	180

Sample ID	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background	17.9	624	--	933	25.8	46.3
RBC	160	--	39	--	55	2,300
MW-55	5.66	455	ND	380	34.0	212
MW-56	6.86	911	ND	349	25.4	29.5
MW-57	5.89	339	ND	510	30.7	26.8
MW-58	6.18	346	ND	261	24.3	25.6
MW-85	7.69	326	ND	554	33.1	45.2
RISB-3	8.04	476	15.3	458	37.6	44.5
RISB-4	6.07	389	ND	457	35.1	18.1
RISB-5	4.53	341	ND	344	26.1	39.4

ND Not detected.

a Site background concentrations are based on WRF site background maximum concentrations for surface soil samples MW-52 through MW-54 and RIBKSS1 through RIBKSS5.

**Table 7-25 (Continued)**  
**Organics Detected in Subsurface Soil Samples (0 to 2 ft bgs)**  
**Collected in AREEs 11 and 17 and North of the Main Compound**

Sample ID	2-Methyl-naphthalene (µg/g)	Acetone (µg/g)	Bis(2-ethyl-hexyl) phthalate (µg/g)	DDE (µg/g)	DDT (µg/g)	Naphthalene (µg/g)	PCB-1260 (µg/g)	TPH as Diesel (µg/g)
<b>RBC</b>	<b>230<sup>a</sup></b>	<b>780</b>	<b>46</b>	<b>1.9</b>	<b>1.9</b>	<b>310</b>	<b>0.083<sup>b</sup></b>	<b>100<sup>c</sup></b>
MW-55	ND	ND	0.26	0.01	0.04	ND	0.29	ND
MW-56	ND	ND	0.18	ND	ND	ND	ND	ND
MW-57	ND	ND	0.56	ND	ND	ND	0.39	ND
MW-58	ND	0.02	0.22	ND	ND	ND	0.02	ND
MW-85	ND	ND	ND	ND	ND	ND	0.339	ND
RISB-3	ND	ND	ND	ND	ND	ND	0.70	ND
RISB-4	ND	ND	ND	ND	ND	ND	0.48	ND
RISB-5	ND	ND	ND	ND	ND	ND	0.12	ND

<sup>a</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>b</sup> Value is for carcinogenic PCBs.

<sup>c</sup> VDEQ action level

-- No value available.

ND Not detected.

RBC USEPA Region III residential risk-based concentration (RBC) values.

**Table 7-25 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft to Water Table)**  
**Collected in AREEs 11 and 17 and North of the Main Compound**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background*		18,200	ND	73.8	1.02	454	25.0
MW-55	12	14,300	ND	112	1.20	1,030	23.2
	15	12,300	ND	88.6	1.29	1,370	30.3
MW-56	10	6,730	ND	52.7	0.59	722	13.4
	15	18,500	0.95	79.7	0.58	640	26.6
MW-57	5	10,800	ND	77.3	0.69	445	15.9
	15	5,290	ND	ND	0.26	433	13.6
MW-57Dup	15	4,080	ND	ND	ND	333	10.5
MW-58	5	4,220	ND	ND	ND	139	7.99
	7	5,090	ND	ND	ND	238	9.44
MW-85	10	3,670	ND	ND	0.341	326	9.94
RISB-3	5	13,400	ND	ND	0.70	223	17.5
RISB-3	10	3,740	ND	ND	0.26	ND	5.63
RISB-4	5	1,800	ND	ND	ND	ND	4.70
RISB-5	5	9,500	ND	57.9	0.43	213	13.6

Sample ID	Depth (ft)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background*		13.9	16.9	27,800	11.8	3,700	617
MW-55	12	12.1	23.1	5,120	11.9	1,440	62.9
	15	27.8	32.1	14,900	ND	3,950	151.0
MW-56	10	3.53	10.7	5,830	ND	1,400	68.7
	15	4.01	8.69	12,800	13.6	2,250	75.6
MW-57	5	3.69	8.88	19,600	11.0	1,160	99.6
	15	ND	4.88	4,940	ND	1,110	44.3
MW-57Dup	15	ND	4.15	7,680	ND	1,100	43.3
MW-58	5	ND	3.43	3,220	ND	483	66.7
	7	3.22	4.43	3,210	ND	749	45.1
MW-85	10	6.54	8.04	3,220	ND	952	33.1
RISB-3	5	13.3	9.20	17,800	10.1	2,150	363.0
	10	6.58	3.34	8,100	ND	403	188.0
RISB-4	5	ND	2.16	1,830	ND	269	16.6
RISB-5	5	2.67	7.92	13,800	10.2	612	27.5

**Table 7-25 (Continued)**  
**Inorganics Detected in Subsurface Soil Samples (2 ft to Water Table)**  
**Collected in AREEs 11 and 17 and North of the Main Compound**

Sample ID	Depth bgs (ft)	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>		17.9	624	--	933	25.8	46.3
MW-55	12	20.3	495	ND	439	40.6	30.7
	15	36.0	844	ND	701	63.4	103
MW-56	10	7.78	651	ND	468	28.9	27.8
	15	8.33	558	ND	412	43.7	25.4
MW-57	5	5.30	477	ND	410	43.9	29.0
	15	5.82	245	ND	398	18.1	23.5
MW-57Dup	15	5.06	171	ND	383	15.0	22.1
MW-58	5	2.52	188	ND	299	10.7	7.69
	7	3.29	314	ND	325	11.1	10.8
MW-85	10	5.97	204	ND	362	16.5	11.7
RISB-3	5	7.86	396	16.3	381	40.4	24.8
	10	ND	167	ND	303	10.2	7.91
RISB-4	5	ND	124	ND	266	4.96	ND
RISB-5	5	3.71	403	13.7	378	29.0	18.3

-- No value available.

ND Not detected.

a Site background concentrations are based on WRF site background maximum concentrations for subsurface soil samples MW-52 through MW-54, at two depths (greater than 2 feet bgs).

**Table 7-25 (Continued)**  
**Organics Detected in Subsurface Soil Samples (2 ft to Water Table)**  
**Collected in AREEs 11 and 17 and North of the Main Compound**

Sample ID	Depth bgs (ft)	2-Methyl-naphthalene (µg/g)	Acetone (µg/g)	Bis(2-ethylhexyl)-phthalate (µg/g)	Naphthalene (µg/g)	PCB-1260 (µg/g)	Phenanthrene (µg/g)
RBC		230 <sup>a</sup>	780	46	310	0.083 <sup>b</sup>	--
MW-55	12	ND	0.02	0.33	ND	ND	ND
	15	ND	ND	0.26	ND	ND	ND
MW-57	5	ND	ND	ND	ND	ND	ND
	15	ND	ND	0.21	ND	ND	ND
MW-57DUP	15	ND	0.01	0.44	ND	ND	ND
MW-58	5	ND	ND	0.37	ND	ND	ND
	7	ND	ND	0.190	ND	ND	ND
MW-85	10	ND	0.030	ND	ND	ND	ND
RISB-3	5	ND	ND	ND	ND	ND	ND
	10	ND	ND	ND	ND	ND	ND
RISB-4	5	ND	ND	ND	ND	ND	ND
RISB-5	5	ND	ND	ND	ND	ND	ND

<sup>a</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>b</sup> Value is for carcinogenic PCBs.

ND Not Detected.

-- No value available.

RBC USEPA Region III risk-based concentration (RBC) values.

**Table 7-26**  
**Inorganics Detected in Groundwater Samples Collected in**  
**AREEs 11 and 17 and North of the Main Compound**

Sample ID	Aluminum µg/L	Arsenic µg/L	Barium µg/L	Cadmium µg/L	Calcium µg/L	Iron µg/L	Lead µg/L
Site Background	12,500	6.70	107	0.8	42,200	9,620	6.3
RBC	3,700	0.045	260	1.8	—	1,100	—
Round 1							
MW-55	209	ND	63.6	0.3	2,460	172	ND
MW-56	137	3.0	52.0	ND	3,160	17,200	ND
MW-57	1,320	1.1	32.8	ND	3,690	14,600	ND
MW-58	250	ND	34.9	ND	2,700	239	ND
MW-61	172	ND	34.9	0.3	7,230	314	ND
MW-62	438	5	81.8	ND	5,610	18,000	ND
MW-84	617	ND	54.2	ND	29,000	7,310	ND
MW-85	327	ND	55.9	ND	4,180	8,430	ND
MW-85Dup	398	ND	58.2	ND	4,360	8,880	ND
Round 2							
MW-55	211	ND	56	0.3	1,940	94.8	ND
MW-56	108	3.8	45.9	ND	2,930	15,800	ND
MW-57	1,450	1.9	32.4	ND	4,030	15,000	ND
MW-58	150	ND	ND	ND	2,120	77.2	ND
MW-62	136	4.2	68.7	ND	5,890	15,300	ND
MW-84	330	ND	45.7	ND	19,700	8,600	ND

**Table 7-26 (Continued)**  
**Inorganics Detected in Groundwater Samples Collected in**  
**AREEs 11 and 17 and North of the Main Compound**

Sample ID	Magnesium µg/L	Manganese µg/L	Potassium µg/L	Selenium µg/L	Sodium µg/L	Zinc µg/L
Site Background	7,720	354	20,600	4.2	43,500	46
RBC	--	18	--	18	--	1,100
Round 1						
MW-55	4,040	91.5	1,210	ND	6,830	182
MW-56	1,500	399	596	ND	5,930	20.4
MW-57	2,180	411	1,030	ND	6,440	ND
MW-58	2,840	104	831	ND	5,700	42.9
MW-62	1,900	562	968	ND	6,820	ND
MW-84	2,280	279	1,710	ND	8,680	ND
MW-85	1,860	471	743	ND	9,810	94.5
MW-85Dup	1,950	493	806	2.40	10,300	ND
Round 2						
MW-55	4,030	70.8	835	ND	6,800	119
MW-56	1,360	370	628	ND	5,490	ND
MW-57	2,330	434	788	ND	6,530	ND
MW-58	2,800	42.4	1,020	ND	5,180	ND
MW-62	1,660	494	915	ND	6,710	ND
MW-84	1,770	248	1,410	ND	7,770	ND

-- No value available.

ND Not detected.

RBC USEPA Region III residential risk-based concentration (RBC) values.

**Table 7-26 (Continued)**  
**Organics Detected in Groundwater Samples Collected in**  
**AREEs 11 and 17 and North of the Main Compound**

Sample ID	1-Methyl naphthalene (µg/L)	2-Methyl naphthalene (µg/L)	Acenaphthene (µg/L)	Acenaphthylene (µg/L)	Acetone (µg/L)	Anthracene (µg/L)
RBC	110*	110*	220	110*	370	1,100
Round 1						
MW-55	ND	ND	ND	ND	ND	ND
MW-56	ND	ND	ND	ND	ND	ND
MW-57	ND	ND	ND	ND	12	ND
MW-58	ND	ND	ND	ND	ND	ND
MW-62	ND	ND	ND	ND	ND	ND
MW-84	ND	ND	2.19	ND	26.0	0.305
MW-85	ND	ND	ND	ND	ND	ND
MW-85-Dup	ND	ND	ND	ND	ND	ND
Round 2						
MW-55	ND	ND	ND	ND	ND	ND
MW-56	ND	ND	ND	ND	ND	ND
MW-57	ND	ND	ND	ND	ND	ND
MW-58	ND	ND	ND	ND	ND	ND
MW-62	ND	ND	ND	ND	ND	ND
MW-84	ND	ND	ND	ND	24	1.20
MW-85	ND	ND	ND	ND	ND	ND



**Table 7-26 (Continued)**  
**Organics Detected in Groundwater Samples Collected in**  
**AREEs 11 and 17 and North of the Main Compound**

Sample ID	Bis(2-ethylhexyl) Phthalate (µg/L)	Chloroform (µg/L)	Dieldrin (µg/L)	Endosulfan sulfate (µg/L)	Ethylbenzene (µg/L)	Fluoranthene (µg/L)
RBC	4.8	0.15	0.0042	22 <sup>b</sup>	130	150
Round 1						
MW-55	2.1	ND	0.009	0.015	ND	ND
MW-56	ND	ND	ND	ND	ND	ND
MW-57	3.5	ND	ND	ND	ND	ND
MW-58	6.6	ND	ND	ND	ND	ND
MW-62	ND	ND	ND	ND	ND	ND
MW-84	11.0	ND	ND	ND	ND	ND
MW-85	ND	ND	ND	ND	ND	ND
MW-85Dup	2.10	ND	ND	ND	ND	ND
Round 2						
MW-55	ND	ND	ND	ND	ND	ND
MW-56	3.7	ND	ND	ND	ND	ND
MW-57	3.5	ND	ND	ND	ND	ND
MW-58	ND	ND	ND	ND	ND	ND
MW-62	17	ND	ND	ND	ND	ND
MW-84	ND	ND	ND	ND	ND	ND
MW-85	ND	ND	ND	ND	ND	ND

**Table 7-26 (Continued)**  
**Organics Detected in Groundwater Samples Collected in**  
**AREEs 11 and 17 and North of the Main Compound**

Sample ID	Fluorene (µg/L)	Naphthalene (µg/L)	Phenanthracene (µg/L)	Phenanthrene (µg/L)	Pyrene (µg/L)
RBC	--	--	110 <sup>a</sup>		110
Round 1					
MW-55	ND	ND	ND	ND	ND
MW-56	ND	ND	ND	ND	ND
MW-57	ND	ND	ND	ND	ND
MW-58	ND	ND	ND	ND	ND
MW-62	ND	ND	ND	ND	
MW-84	ND	ND	2.93	ND	0.19
MW-85	ND	ND	ND	ND	ND
MW-85Dup	ND	ND	ND	ND	ND
Round 2					
MW-55	ND	ND	ND	ND	ND
MW-56	ND	ND	ND	ND	ND
MW-57	ND	ND	ND	ND	ND
MW-58	ND	ND	ND	ND	ND
MW-62	ND	ND	ND	ND	
MW-84	ND	ND	ND	0.715	ND
MW-85	ND	ND	ND	ND	ND

<sup>a</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>b</sup> The RBC for endosulfan was used.

-- No value available.

ND Not detected.

RBC USEPA Region III residential risk-based concentration (RBC) values.

**Table 7-27**  
**Compounds Detected in Sediment Samples Collected from the Main Ditch (OU3)**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)
Site Background	15,200	175	1.25	6,000	30.1	20.7	41.8	34,200
RISD24	7,210	ND	ND	2,070	25.4	14.8	18.8	19,200
RISD24Dup	6,630	ND	0.615	2,850	25.6	17.4	22.9	20,000
RISD26	15,600	187	1.37	1,330	20.2	8.33	21.5	34,600
RISD27	15,400	117	0.715	2,020	21.2	11.2	19.1	18,200
RISD28	15,200	145	1.02	1,820	22.6	16.7	24	18,800
RISD29	10,600	86.3	1.05	694	15.5	8.19	14	22,500
RISD30	12,500	154	1.93	2,370	18.1	19.1	15.9	17,000
RISD31	9,850	75.8	1.16	1,030	13.5	8.5	12.5	10,300
RISD32	15,900	191	2.44	2,410	23.0	27.3	25.9	19,400
RISD33	8,980	135	1.14	1,710	13.3	20.1	18.3	17,600
RISD34	14,500	173	1.41	2,130	20.6	36.1	23.4	18,100
RISD35	12,500	139	1.03	1,300	19.1	15	19	17,300
RISD36	21,200	236	1.67	3,360	32	22.3	46.7	26,200
RISD37	20,900	ND	ND	5,140	40.5	34.2	59.3	39,700
RISD38	1,740	ND	ND	471	11.3	ND	5.27	6,940
RISD39	952	ND	ND	174	12.1	2.68	2.37	6,740
RISD40	11,500	ND	ND	4,840	24.2	16.7	41.4	20,300

Sample ID	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background	42.2	3,470	1,690	30.0	2,120	1,710	52.5	157
RISD24	18.4	1,440	357	19.6	781	878	52.3	68.3
RISD24Dup	ND	1,570	449	16.2	666	1,120	62.1	83.5
RISD26	42.6	1200	73.4	13.5	1040	911	68.8	70.1
RISD27	51.9	1830	361	10.4	991	944	46.5	116
RISD28	84.5	1760	315	12.8	840	599	51	194
RISD29	64.3	772	104	8	499	661	49.3	57.6
RISD30	36.4	1,450	391	15.2	843	697	44.1	107
RISD31	20.9	1,010	216	7.72	542	565	28.9	63.2
RISD32	50.6	1,760	424	18.4	818	1,240	57.9	192
RISD33	35.1	1,090	438	11.4	483	890	40.5	123
RISD34	47.5	1,570	564	19.1	782	1,170	43.1	257
RISD35	27.4	1,650	338	13.4	772	1,020	42.5	99.6
RISD36	50.6	3,120	712	24.5	1,410	1,650	72.7	188
RISD37	55.9	3,750	985	35.8	1,810	1,880	83.3	222
RISD38	ND	397	234	3.56	264	531	15.5	26.6
RISD39	ND	224	277	ND	ND	326	19.8	23.3
RISD40	ND	2,540	461	26.4	1,070	2,790	52.6	117

**Table 7-27 (Continued)**  
**Compounds Detected in Sediment Samples Collected from the Main Ditch (OU3)**

Sample ID	1-Methylnaphthalene (µg/g)	2-Methylnaphthalene (µg/g)	Acenaphthene (µg/g)	Alpha-chlordane (µg/g)	Anthracene (µg/g)	Benzo(a)anthracene (µg/g)	Benzo(a)pyrene (µg/g)	Benzo(b)fluoranthene (µg/g)
ER-L	NA	ND	0.016	ND	0.085	0.261	0.43	--
RISD26	0.888	0.946	<0.133	<0.003	0.057	0.013	0.021	0.029
RISD27	0.721	0.818	<0.133	0.016	0.19	0.049	0.109	0.12
RISD28	<0.133	0.428	<0.133	0.021	0.028	0.035	0.072	0.107
RISD29	0.586	0.564	<0.133	<0.003	0.083	0.009	0.015	0.02
RISD30	0.952	0.721	<0.133	<0.003	0.103	0.18	0.03	0.044
RISD31	<0.133	0.926	<0.133	<0.003	0.023	0.004	0.004	0.009
RISD32	<0.133	1.01	<0.133	<0.003	0.065	<0.013	0.054	0.109
RISD33	0.635	0.574	<0.133	<0.003	0.032	0.034	0.192	0.094
RISD34	1.03	1.24	1.31	<0.003	0.037	0.022	0.098	0.06
RISD35	1.11	1.78	<0.133	<0.003	0.155	0.591	0.596	0.347

Sample ID	Benzo(g,h,i)perylene (µg/g)	Benzo(k)fluoranthene (µg/g)	Benzoic Acid (µg/g)	Chrysene (µg/g)	Chlordane (µg/g)	DDD (µg/g)	Dibenzo(a,h)anthracene (µg/g)
ER-L	--	--	--	0.384	0.0005	0.002	0.0634
RISD24	0.03	ND	ND	0.037	ND	ND	ND
RISD24Dup	0.025	0.012	ND	ND	ND	ND	ND
RISD26	0.028	0.013	3.1	0.039	<0.020	<0.003	<0.003
RISD27	0.091	0.057	<0.70	0.027	<0.020	0.016	0.012
RISD28	0.087	0.054	<0.70	0.032	0.263	<0.003	0.014
RISD29	<0.007	0.01	<0.14	0.026	0.041	<0.003	<0.003
RISD30	0.043	0.022	<0.14	0.064	<0.020	<0.003	<0.003
RISD31	<0.007	0.003	1	0.019	<0.020	<0.003	<0.003
RISD32	0.056	0.048	<0.28	0.115	<0.020	<0.003	<0.003
RISD33	0.021	<0.018	<0.29	0.072	<0.020	<0.003	0.012
RISD34	<0.067	0.02	<0.14	0.095	<0.020	<0.003	<0.033
RISD35	<0.168	0.197	<0.28	0.48	<0.020	0.024	<0.083
RISD36	0.141	0.143	ND	0.463	ND	ND	ND
RISD37	0.09	0.08	ND	0.044	ND	ND	0.022
RISD38	0.031	ND	ND	ND	ND	ND	ND
RISD39	0.011	0.004	ND	ND	ND	ND	ND
RISD40	3.43	ND	ND	ND	ND	ND	ND

**Table 7-27 (Continued)**  
**Compounds Detected in Sediment Samples Collected from the Main Ditch (OU3)**

Sample ID	Fluoranthene (µg/g)	Fluorene (µg/g)	Gamma- chlordane (µg/g)	Indeno (1,2,3-cd) pyrene (µg/g)	Naphthalene (µg/g)	PCB-1260 (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)	TPH, as Diesel (µg/g)
ER-L	0.6	0.019	ND	--	0.16	--	0.24	0.665	--
RISD24	0.194	ND	ND	ND	0.342	ND	22.9	0.32	ND
RISD24Dup	0.039	2.94	ND	0.013	20.1	ND	0.191	1.03	ND
RISD26	0.045	0.459	<0.003	0.016	0.858	<0.013	0.126	0.034	31.4
RISD27	0.167	<0.033	0.022	0.061	<0.133	<0.013	0.109	0.219	<8.0
RISD28	0.153	<0.033	0.03	0.072	<0.133	<0.013	0.1	0.128	<8.0
RISD29	0.031	<0.033	<0.003	0.015	<0.133	<0.013	0.103	<0.007	<8.0
RISD30	0.054	<0.033	<0.003	0.012	<0.133	<0.013	0.097	0.078	<8.0
RISD31	0.014	<0.033	<0.003	<0.003	2.9	1.25	<0.033	0.011	<8.0
RISD32	0.136	<0.033	<0.003	0.034	0.558	6.04	<0.033	0.133	<8.0
RISD33	0.104	<0.033	<0.003	<0.083	<0.133	3.45	0.356	0.048	23.5
RISD34	0.137	<0.033	<0.003	<0.033	<0.133	0.54	0.915	0.065	36.2
RISD35	0.768	0.313	<0.003	0.227	0.38	0.043	0.68	0.955	<8.0
RISD36	1.01	ND	ND	0.071	0.88	ND	0.697	1.17	ND
RISD37	0.33	ND	ND	0.861	1.12	ND	ND	0.595	ND
RISD38	0.052	ND	ND	0.023	ND	ND	ND	0.116	ND
RISD39	0.015	ND	ND	0.008	ND	ND	ND	0.011	ND
RISD40	0.246	0.229	ND	0.639	ND	ND	ND	0.18	ND

Sediment samples collected from OU3 were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH.

ND -- Not detected.

ER-L -- Effects Range-Low, Long and Morgan, 1990.

<sup>a</sup> -- Laboratory Reporting Limit.

-- No value available.

**Table 7-28**  
**Compounds Detected in Surface Water Samples Collected from the Main Ditch (OU3)**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)
Site Background	1,930	1*	41.8	0.5*	22,200	10.8	ND	2,510	1.9
RISW24	595	ND	31.2	ND	15,700	ND	ND	1,140	1.4
RISW24Dup	800	ND	32.6	ND	15,800	ND	ND	1,500	1.6
RISW26	16,100	2.9	109	0.2	4,840	12.6	7.8	17,300	13
RISW27	11,900	2.7	68.1	0.1	8,250	11.7	6.7	11,600	9.2
RISW28	13,500	<1.0	71.6	<1.0	8,600	12.0	7.8	12,100	<1.0
RISW29	13,900	3.1	69.4	<1.0	8,190	10.9	8.2	12,100	8.8
RISW30	13,700	2.2	69.4	0.1	6,950	10.3	6.5	11,300	7.6
RISW31	13,100	2.5	67.5	0.3	6,580	<10.0	7.3	10,200	7.8
RISW32	13,200	2.1	69.3	0.1	6,070	11.1	6.4	10,300	8.0
RISW33	12,200	2.2	65.8	0.1	6,010	14.8	7.6	10,300	7.6
RISW34	12,800	2.2	70	0.1	5,960	12.2	7.3	10,800	7.9
RISW35	10,500	1.6	58.2	<1.0	4,970	<10.0	5.1	7,900	4.8
RISW36	8,960	1.6	56.4	ND	5,140	10.5	6.8	8,320	5.7
RISW37	9,230	1.2	53.6	ND	5,760	ND	6.7	8,190	5.3
RISW38	2,890	ND	46.1	ND	16,100	ND	ND	4,210	3.0
RISW39	5,510	ND	58.4	0.1	15,200	ND	9.9	6,360	5.6
RISW40	636	ND	25.8	ND	14,100	ND	ND	1,520	1.1

**Table 7-28 (Continued)**  
**Compounds Detected in Surface Water Samples collected from the Main Ditch (OU3)**

Sample ID	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
Site Background	7,500	303	<15*	3,670	<2.0*	16,500	ND	ND	ND
RISW24	5,720	186	ND	4,260	2.2	20,500	ND	ND	ND
RISW24Dup	5,800	189	ND	4,180	ND	20,800	ND	ND	ND
RISW26	2,750	403	<15	3,670	<2.0	2,110	0.2	30.1	78
RISW27	2,810	624	<15	4,270	<2.0	2,630	0.2	24.7	41.2
RISW28	2,900	590	<15	4,280	<2.0	2,650	<0.1	26.6	43.6
RISW29	2,840	539	<15	3,950	<2.0	2,520	0.2	28.1	44.4
RISW30	2,660	339	<15	3,520	<2.0	2,370	0.1	25.3	43.7
RISW31	2,550	318	<15	3,530	<2.0	2,350	0.2	24.5	42.8
RISW32	2,530	277	<15	3,610	<2.0	2,170	0.1	24.7	49.5
RISW33	2,500	228	<15	3,570	<2.0	2,130	0.1	24.2	50.4
RISW34	2,570	171	<15	3,590	<2.0	2,170	0.2	25.3	46.2
RISW35	2,460	197	<15	3,990	<2.0	2,330	<0.1	17.5	30.7
RISW36	2,350	145	ND	3,340	ND	2,140	ND	17.9	28.9
RISW37	2,640	225	ND	3,680	ND	2,830	ND	19.9	24.4
RISW38	5,960	677	ND	4,650	2.5	16,500	ND	ND	ND
RISW39	5,320	346	ND	3,640	ND	10,100	ND	14.5	24.7
RISW40	5,130	259	ND	4,810	ND	15,300	ND	ND	ND

Surface water samples collected from OU3 were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and TPH.

ND -- Not detected.

a -- Laboratory Reporting Limit.

**Table 7-29**  
**Inorganics Detected in Subsurface Soil Samples**  
**Collected in AREE 23a**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)
Site Background <sup>a</sup>		18,200	1.02	454	250	13.9	16.9
RISB-7	5	6,820	0.383	664	10.7	ND	6.23
	15	13,900	0.897	871	25.9	6.22	14.9
	25	3,700	0.749	456	9.4	ND	6.67

Sample ID	Depth bgs (ft)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)
Site Background <sup>a</sup>		27,800	11.8	3,700	617	17.9	624
RISB-7	5	6,440	ND	652	31	2.73	296
	15	50,200	10	1,670	116	8.7	643
	25	15,900	ND	489	49.9	4.06	251

Sample ID	Depth bgs (ft)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>		933	25.8	46.3
RISB-7	5	381	17	14.6
	15	371	47.5	27.4
	25	473	13.4	12.6

-- No value available.

ND Not detected.

a Site background concentrations are based on WRF site background maximum concentrations for subsurface soils collected from MW-52 through MW-54 at two depths (greater than 2 feet bgs).



**Table 7-30**  
**Inorganics Detected in Surface Soil Samples**  
**Collected in AREE 39**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)
Site Background <sup>a</sup>	14,350	92.4	0.814	1,150	31.1	16.6
RISS-57	5,300	ND	0.352	474	7.9	4.76
RISS-58	6,580	60.1	0.617	496	13.7	10.7
RISS-59	7,110	79.4	ND	556	18	11
RISS-59Dup	ND	76.3	0.612	463	21.6	11.2

Sample ID	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)
Site Background <sup>a</sup>	12.6	28,100	22.4	2,610	875	11.9
RISS-57	4.45	8,550	ND	906	225	3.68
RISS-58	8.96	13,000	11.5	924	713	5.83
RISS-59	44.2	16,400	19.3	898	800	7.35
RISS-59Dup	51.4	16,600	18.4	841	795	7.06

Sample ID	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background <sup>a</sup>	936	487	58.9	43.9
RISS-57	332	237	18	12.8
RISS-58	383	246	29.1	24.4
RISS-59	450	280	39.8	47.2
RISS-59Dup	384	275	39.6	45.5

-- No value available.

ND Not detected.

a Site background concentrations are based on WRF site background maximum concentrations for surface soil samples MW-52 through MW-54 and RIBKSS1 through RIBKSS5.

**Table 7-31**  
**Organics Detected in Groundwater Samples Collected in AREE 41**

Sample ID	Date	1-Methyl naphthalene (µg/L)	2-Methyl naphthalene (µg/L)	Acenaphthene (µg/L)	Acenaphthylene (µg/L)	Acetone (µg/L)	Anthracene (µg/L)
<b>RBC</b>		<b>110*</b>	<b>110*</b>	<b>220</b>	<b>110*</b>	<b>370</b>	<b>1,100</b>
MW-63	8/15/96	ND	46	ND	ND	ND	ND
MW-63	3/13/96	101	79.3	4.17	3.01	89	2
MW-63Dup	3/13/96	ND	78.8	8.27	ND	94	2.76
MW-63	12/28/95	119	80.5	11	6.34	25	ND
MW-86	9/13/96	ND	ND	ND	ND	ND	ND
MW-86Dup	9/13/96	ND	ND	ND	ND	ND	ND
MW-87	9/13/96	ND	ND	ND	ND	ND	ND
PZ-4	8/13/96	ND	ND	ND	ND	ND	ND

Sample ID	Date	beta BHC (µg/L)	Endosulfan (µg/L)	bis(2- ethylhexyl) phthalate (µg/L)	Chloroform (µg/L)	delta-BHC (µg/L)	Dibenzofuran (µg/L)
<b>RBC</b>		<b>---</b>	<b>--</b>	<b>4.8</b>	<b>0.15</b>	<b>0.0042</b>	<b>15</b>
MW-63	8/15/96	ND	ND	3.3	ND	0.012	ND
MW-63	3/13/96	0.017	ND	4.2	ND	ND	ND
MW-63Dup	3/13/96	ND	ND	2.5	ND	ND	2.8
MW-63	12/28/95	ND	0.021	7.7	ND	ND	ND
MW-86	9/13/96	ND	ND	4.8	3.47	ND	ND
MW-86Dup	9/13/96	ND	ND	2.7	3.67	ND	ND
MW-87	9/13/96	ND	ND	ND	ND	ND	ND
PZ-4	8/13/96	ND	ND	ND	ND	ND	ND

Sample ID	Date	Dieldrin (µg/L)	Endosulfan sulfate (µg/L)	Endrin (µg/L)	Ethylbenzene (µg/L)	Fluoranthene (µg/L)	Fluorene (µg/L)
<b>RBC</b>		<b>0.0042</b>	<b>22<sub>L</sub></b>	<b>1.1</b>	<b>130</b>	<b>150</b>	<b>--</b>
MW-63	8/15/96	ND	ND	ND	ND	ND	3.2
MW-63	3/13/96	0.026	0.019	ND	5.3	0.069	1.87
MW-63Dup	3/13/96	0.018	ND	ND	5.2	0.069	2.01
MW-63	12/28/95	ND	0.027	0.022	13	0.063	2.7
MW-86	9/13/96	ND	ND	ND	ND	ND	ND
MW-86Dup	9/13/96	ND	ND	ND	ND	ND	ND
MW-87	9/13/96	ND	ND	ND	ND	ND	ND
PZ-4	8/13/96	ND	ND	ND	ND	ND	ND

**Table 7-31 (Continued)**  
**Organics Detected in Groundwater Samples Collected in AREE 41**

Sample ID	Date	gamma BHC (lindane) (µg/L)	Naphthalene (µg/L)	Phenanthrene (µg/L)	Pyrene (µg/L)	Toluene (µg/L)	TPH as diesel (µg/L)
RBC		--	--	--	110	75	
MW-63	8/15/96	ND	9.2	ND	ND	ND	645
MW-63	3/13/96	0.098	18	6.43	0.162	2.3	1,140
MW-63Dup	3/13/96	ND	15.2	6.35	0.137	2.1	1,130
MW-63	12/28/95	ND	30	8.69	.158	5.2	900
MW-86	9/13/96	ND	ND	ND	ND	ND	ND
MW-86Dup	9/13/96	ND	ND	ND	ND	ND	ND
MW-87	9/13/96	ND	ND	ND	ND	ND	ND
PZ-4	8/13/96	0.009	ND	ND	ND	ND	ND

Sample ID	Date	TPH as Gas (µg/L)	Xylenes
RBC		--	1,200
MW-63	8/15/96	ND	9.87
MW-63	3/13/96	558	32
MW-63Dup	3/13/96	538	31
MW-63	12/28/95	740	54
MW-86	9/13/96	ND	ND
MW-86Dup	9/13/96	ND	ND
MW-87	9/13/96	ND	ND
PZ-4	8/13/96	ND	ND

<sup>a</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>b</sup> The RBC for endosulfan was used.

-- No value available.

ND Not detected.

RBC USEPA Region III residential risk-based concentration (RBC) values.

**Table 7-32**  
**Inorganics Detected in Surface Soil Samples Collected Site Wide**

Sample ID	Aluminum (µg/g)	Arsenic (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background	14,350	3.8	92.4	0.814	1,150	31.3
RBC	7,800	0.43	550	0.15	--	39
RISS-26	17,800	ND	ND	0.471	653	39.2
RISS-27	25,400	ND	ND	1.266	728	17.5
RISS-28	6,110	ND	ND	0.441	728	12.8
RISS-29	5,410	ND	73.3	0.599	911	11.1
RISS-30	6,310	ND	81.7	1.31	460	8.7
RISS-31	3,890	ND	ND	1.08	331	8.57
RISS-31Dup	3,170	ND	ND	1.18	364	6.98
RISS-32	5,190	ND	65.1	0.688	672	15.3
RISS-33	5,170	ND	57.7	0.838	558	20.0
RISS-34	6,700	ND	78.6	0.641	687	22.3
RISS-35	9,080	ND	100	1.31	926	26.4
RISS-36	8,180	ND	ND	0.568	820	17.9
RISS-37	8,040	ND	57.4	1.18	342	17.4
RISS-38	4,730	ND	51.1	0.597	261	14.3
RISS-39	7,050	ND	ND	0.539	761	12.2
RISS-40	5,990	ND	ND	0.534	679	12.4
RISS-41	7,710	ND	ND	0.746	642	23.6
RISS-41Dup	7,260	ND	ND	0.768	637	18.8
RISS-42	3,230	ND	ND	0.296	294	7.84
RISS-43	5,430	ND	ND	0.295	797	18.9
RISS-44	8,300	ND	81.4	0.93	909	21.1
RISS-45	8,660	ND	51.4	1.03	473	17.7
RISS-46	7,170	ND	76.5	0.836	216	18.7
RISS-47	11,400	ND	50.1	0.69	569	25.4
RISS-48	6,830	ND	ND	0.329	920	12.2
RISS-49	10,700	2.96	94.2	0.919	901	17.2
RISS-50	6,640	ND	45.2	0.684	273	12.5

**Table 7-32 (Continued)**  
**Inorganics Detected in Surface Soil Samples Collected Site Wide**

Sample ID	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background	16.6	12.6	28,100	22.4	2,610	875
RBC	470	310	2,500	400	--	180
RISS-26	6.88	13.22	35,000	24.6	2,140	174.8
RISS-27	8.32	7.73	31,400	18.74	3,360	268
RISS-28	4.69	6.31	9,200	13.8	1,160	128
RISS-29	8.43	5.65	10,600	13.5	629	1,110
RISS-30	6.89	6.11	10,400	16.2	721	953
RISS-31	7.27	5.45	7,950	11.2	336	991
RISS-31Dup	5.2	4.53	6,640	12.7	318	719
RISS-32	9.83	6.92	12,600	17.8	649	960
RISS-33	10.1	9.11	15,300	18.3	684	651
RISS-34	14	10.1	17,800	19.9	836	962
RISS-35	16.2	11.2	22,900	20.7	1,180	1,440
RISS-36	4.28	11.6	21,400	12.1	1,520	61.4
RISS-37	9.74	11.4	19,000	14.4	1,010	395
RISS-38	9.03	6.85	11,900	13.7	516	633
RISS-39	3.12	8.93	13,900	19.1	747	83.2
RISS-40	3.83	4.59	14,200	11.9	710	74.6
RISS-41	6.7	4.97	22,800	20.1	740	170
RISS-41Dup	5.01	4.43	19,300	14.7	724	129
RISS-42	6.04	6.27	8,130	9.78	395	368
RISS-43	7.99	8.14	13,800	20.1	716	417
RISS-44	14.5	11.5	19,300	14.1	1,170	1,300
RISS-45	13.3	13.1	17,100	14.5	1,280	555
RISS-46	7.09	401	18,300	19.2	932	672
RISS-47	8.08	6.07	23,400	15.3	857	135
RISS-48	4.1	5.25	12,200	12.4	655	83.4
RISS-49	21.2	5.13	16,000	19.8	902	1,750
RISS-50	8.16	4.95	9,460	12.6	822	362

**Table 7-32 (Continued)**  
**Inorganics Detected in Surface Soil Samples Collected Site Wide**

Sample ID	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background	11.9	936	14.2	487	58.9	43.9
RBC	160	--	39	--	55	2,300
RISS-26	5.78	1,298	ND	405	37.2	20.6
RISS-27	8.26	528	15.4	864	73.2	50.6
RISS-28	5.5	575	ND	459	24.1	25.0
RISS-29	6.19	529	ND	458	24.9	30.5
RISS-30	5.53	352	ND	410	24.1	22.2
RISS-31	3.18	162	ND	433	19.4	15.5
RISS-31 Dup	2.71	188	ND	428	16.9	14.3
RISS-32	4.46	193	ND	426	34.8	18.9
RISS-33	5.66	360	ND	420	39.0	24.5
RISS-34	8.56	325	ND	474	55.2	28.2
RISS-35	10	389	ND	524	58.4	36.6
RISS-36	7.29	636	ND	485	32.3	27.1
RISS-37	7.31	401	ND	433	47.6	26.0
RISS-38	5.21	305	ND	410	29.2	17.9
RISS-39	4.03	458	ND	449	30.3	34.4
RISS-40	3.92	247	ND	464	28.7	14.7
RISS-41	4.01	281	ND	409	48.0	32.1
RISS-41 Dup	3.8	274	ND	474	42.3	31.9
RISS-42	3.75	295	ND	340	19.7	13.8
RISS-43	4.96	298	ND	542	35.7	21.6
RISS-44	8.77	403	ND	477	49.7	27.1
RISS-45	8.34	436	ND	460	42.4	35.0
RISS-46	6.41	408	ND	438	28.2	34.9
RISS-47	5.58	370	ND	378	46.4	26.2
RISS-48	3.74	366	ND	391	24.4	20.4
RISS-49	9.18	344	ND	355	33.2	27.8
RISS-50	5.4	376	ND	373	21.2	18.2

-- No value available.

ND Not detected.

RBC Region III residential risk-based concentration (RBC) value.

RISS 64, 65, and 66 Phase II Sampling were not analyzed for Inorganics.

**Table 7-33**  
**Organics Detected in Surface Soil Samples Collected Site Wide**

Sample ID	1-Methyl-naphthalene (µg/g)	2-Methyl-naphthalene (µg/g)	Acenaphthalene (µg/g)	Acenaphthylene (µg/g)	Alpha-chlordane (µg/g)	Anthracene (µg/g)
RBC	230*	230*	470	--	--	2,300
RISS-26	ND	ND	ND	ND	ND	ND
RISS-27	ND	ND	0.261	ND	ND	ND
RISS-28	ND	ND	ND	ND	ND	0.018
RISS-29	ND	ND	ND	ND	ND	0.036
RISS-30	ND	ND	ND	ND	ND	0.026
RISS-31	0.639	ND	ND	ND	ND	0.018
RISS-31 Dup	ND	ND	ND	ND	ND	0.01
RISS-32	ND	ND	0.755	ND	ND	ND
RISS-33	ND	ND	0.784	ND	ND	0.036
RISS-34	ND	ND	ND	ND	ND	0.01
RISS-35	ND	ND	ND	ND	ND	ND
RISS-36	ND	ND	ND	ND	ND	ND
RISS-37	ND	ND	ND	ND	ND	ND
RISS-38	ND	ND	26.7	ND	ND	0.015
RISS-39	0.349	0.825	0.229	0.635	ND	0.396
RISS-40	ND	ND	ND	ND	ND	ND
RISS-41	ND	ND	ND	ND	ND	0.089
RISS-41 Dup	ND	ND	ND	ND	ND	0.066
RISS-42	ND	ND	0.295	ND	ND	0.015
RISS-43	ND	ND	ND	ND	ND	ND
RISS-44	ND	ND	ND	ND	ND	0.025
RISS-45	ND	ND	ND	ND	ND	ND
RISS-46	ND	ND	ND	ND	ND	0.027
RISS-47	ND	ND	ND	ND	0.007	ND
RISS-48	ND	ND	ND	ND	ND	ND
RISS-49	ND	ND	ND	ND	ND	ND
RISS-50	ND	ND	0.219	ND	ND	0.048
RISS-64	ND	ND	ND	ND	ND	ND

**Table 7-33 (Continued)**  
**Organics Detected in Surface Soil Samples Collected Site Wide**

Sample ID	Benzo(a)-anthracene (µg/g)	Benzo(a)pyrene (µg/g)	Benzo(b)-fluoranthene (µg/g)	Benzo(g,h,i)-perylene (µg/g)	Benzo(k)-fluoranthene (µg/g)	Benzoic Acid (µg/g)
RBC	0.88	0.088	0.88	230*	8.8	31,000
RISS-26	0.004	0.006	0.01	ND	0.004	ND
RISS-27	0.002	0.004	0.004	ND	0.002	0.16
RISS-28	0.012	0.016	0.014	0.02	0.007	ND
RISS-29	ND	0.025	0.029	0.033	0.013	ND
RISS-30	0.007	0.011	0.013	0.012	0.007	ND
RISS-31	0.003	0.005	0.007	0.01	0.003	ND
RISS-31Dup	0.004	0.006	0.008	0.011	0.004	0.2
RISS-32	0.004	0.008	0.009	0.015	0.004	ND
RISS-33	0.006	0.01	0.012	0.019	0.006	ND
RISS-34	0.011	0.016	0.017	0.03	0.009	0.74
RISS-35	0.004	0.005	0.006	ND	0.003	0.41
RISS-36	ND	0.002	0.002	ND	0.001	ND
RISS-37	ND	0.001	0.002	ND	0.001	ND
RISS-38	0.006	0.009	0.011	0.02	0.006	ND
RISS-39	0.488	ND	0.363	0.412	0.156	ND
RISS-40	0.003	0.007	0.007	0.013	0.004	ND
RISS-41	0.006	0.011	0.019	0.022	0.01	ND
RISS-41Dup	0.007	0.012	0.02	0.025	0.01	ND
RISS-42	0.008	0.013	0.011	0.015	0.006	ND
RISS-43	0.003	0.006	0.011	ND	0.005	ND
RISS-44	0.009	0.013	0.012	0.01	0.007	ND
RISS-45	ND	0.001	0.003	ND	0.001	ND
RISS-46	0.005	0.01	0.013	0.018	0.006	ND
RISS-47	0.005	0.009	0.009	0.014	0.005	ND
RISS-48	0.004	0.007	0.008	0.013	0.004	ND
RISS-49	0.007	0.008	0.01	0.014	0.005	ND
RISS-50	0.002	0.003	0.003	ND	0.002	ND
RISS-64	ND	ND	ND	ND	ND	ND



**Table 7-33 (Continued)**  
**Organics Detected in Surface Soil Samples Collected Site Wide**

Sample ID	Bis(2-ethyl-hexyl)phthalate (µg/g)	Chrysene (µg/g)	DDD (µg/g)	DDE (µg/g)	DDT (µg/g)	Dibenzo(a,h) anthracene (µg/g)
RBC	46	86	2.7	1.9	1.9	0.068
RISS-26	ND	ND	ND	ND	ND	ND
RISS-27	ND	ND	ND	ND	ND	ND
RISS-28	ND	ND	ND	ND	ND	ND
RISS-29	ND	ND	ND	ND	ND	ND
RISS-30	ND	ND	ND	ND	ND	ND
RISS-31	ND	ND	ND	0.069	0.019	ND
RISS-31Dup	ND	ND	ND	0.057	0.017	ND
RISS-32	ND	ND	ND	0.249	0.081	ND
RISS-33	ND	ND	0.066	0.559	0.458	ND
RISS-34	ND	ND	ND	0.009	0.006	0.006
RISS-35	7.5	ND	ND	ND	ND	ND
RISS-36	ND	ND	ND	ND	ND	ND
RISS-37	0.18	ND	ND	ND	ND	ND
RISS-38	ND	ND	ND	ND	ND	0.008
RISS-39	ND	0.605	ND	ND	ND	ND
RISS-40	ND	ND	ND	ND	ND	ND
RISS-41	ND	0.015	ND	ND	ND	0.004
RISS-41Dup	ND	0.012	ND	ND	ND	0.005
RISS-42	ND	ND	ND	ND	ND	ND
RISS-43	ND	ND	ND	ND	ND	ND
RISS-44	ND	ND	ND	ND	ND	ND
RISS-45	0.31	ND	ND	ND	ND	ND
RISS-46	ND	ND	ND	ND	ND	ND
RISS-47	ND	ND	0.491	0.213	0.948	ND
RISS-48	ND	ND	ND	ND	ND	ND
RISS-49	ND	ND	ND	ND	ND	ND
RISS-50	ND	ND	ND	ND	ND	ND
RISS-64	ND	ND	ND	ND	0.004	ND

**Table 7-33 (Continued)**  
**Organics Detected in Surface Soil Samples Collected Site Wide**

Sample ID	Diethyl phthalate (µg/g)	Fluoranthene (µg/g)	Fluorene (µg/g)	Gamma- chlordane (µg/g)	Indeno(1,2,3- cd)pyrene (µg/g)	Methoxychlor (µg/g)
RBC	6,300	310	310	—	0.88	39
RISS-26	ND	0.007	ND	ND	ND	ND
RISS-27	ND	0.005	ND	ND	ND	ND
RISS-28	ND	0.021	ND	ND	0.008	ND
RISS-29	ND	0.026	ND	ND	0.013	ND
RISS-30	ND	0.015	ND	ND	0.015	ND
RISS-31	ND	0.008	ND	ND	ND	ND
RISS-31Dup	ND	0.012	ND	ND	0.004	ND
RISS-32	ND	0.009	ND	ND	0.006	0.007
RISS-33	ND	0.011	ND	ND	0.007	0.009
RISS-34	ND	0.021	ND	ND	0.01	ND
RISS-35	ND	0.007	0.078	ND	ND	ND
RISS-36	ND	0.005	ND	ND	ND	ND
RISS-37	ND	0.003	ND	ND	ND	ND
RISS-38	ND	0.013	ND	ND	0.016	ND
RISS-39	ND	0.998	0.121	ND	0.158	ND
RISS-40	ND	0.007	ND	ND	0.004	ND
RISS-41	ND	0.061	ND	ND	0.009	ND
RISS-41Dup	ND	0.032	ND	ND	0.011	ND
RISS-42	ND	0.017	ND	ND	0.011	ND
RISS-43	ND	0.008	ND	ND	0.007	ND
RISS-44	ND	0.028	ND	ND	0.009	ND
RISS-45	0.34	0.003	ND	ND	ND	ND
RISS-46	ND	0.017	ND	ND	0.007	ND
RISS-47	0.55	0.008	ND	0.007	0.006	ND
RISS-48	0.75	0.008	ND	ND	0.005	ND
RISS-49	0.35	0.012	ND	ND	0.006	ND
RISS-50	ND	0.005	ND	ND	ND	ND
RISS-64	ND	ND	ND	ND	ND	ND

**Table 7-33 (Continued)**  
**Organics Detected in Surface Soil Samples Collected Site Wide**

Sample ID	Methylene chloride (µg/g)	Naphthalene (µg/g)	PCB-1248 (µg/g)	PCB-1254 (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)
RBC	85	310	0.083 <sup>b</sup>	0.16	230 <sup>a</sup>	230
RISS-26	0.04	ND	ND	ND	ND	ND
RISS-27	ND	ND	ND	ND	ND	0.01
RISS-28	0.01	ND	ND	ND	ND	0.02
RISS-29	0.02	ND	ND	ND	ND	0.024
RISS-30	ND	ND	ND	ND	ND	0.038
RISS-31	ND	ND	ND	ND	ND	0.009
RISS-31 Dup	0.01	ND	ND	ND	ND	ND
RISS-32	ND	0.806	ND	ND	ND	ND
RISS-33	ND	0.406	ND	ND	ND	0.011
RISS-34	ND	ND	ND	ND	ND	0.018
RISS-35	ND	ND	ND	ND	ND	ND
RISS-36	ND	ND	ND	ND	ND	ND
RISS-37	ND	ND	ND	ND	ND	ND
RISS-38	ND	33.4	ND	ND	ND	0.013
RISS-39	ND	1.25	ND	ND	1.87	1.82
RISS-40	ND	ND	ND	ND	ND	ND
RISS-41	ND	ND	ND	ND	0.04	0.049
RISS-41 Dup	ND	ND	ND	ND	ND	0.028
RISS-42	ND	ND	ND	ND	ND	0.038
RISS-43	ND	ND	ND	ND	ND	0.019
RISS-44	ND	ND	0.228	0.038	ND	0.081
RISS-45	ND	0.445	ND	ND	ND	ND
RISS-46	ND	ND	ND	ND	ND	0.013
RISS-47	ND	ND	ND	ND	ND	ND
RISS-48	ND	ND	ND	ND	ND	ND
RISS-49	ND	ND	ND	ND	ND	0.01
RISS-50	ND	ND	ND	ND	ND	0.01
RISS-64	ND	ND	ND	ND	ND	ND

<sup>a</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>b</sup> Value is for carcinogenic PCBs.

-- No value available.

ND Not detected.

RBC USEPA Region III risk-based concentration (RBC) value.

No organics were detected in RISS 65 and 66.

**Table 7-34**  
**Inorganics Detected in Site Wide Subsurface Soil Samples (0 to 2 ft bgs)**

Sample ID	Aluminum (µg/g)	Antimony (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)
Site Background	18,200	ND	73.8	1.02	454	25.0
RBC	7,800	3.1	550	.015	--	39
PZ-3	15,700	ND	72.4	0.58	489	21.8
PZ-4	10,200	ND	ND	0.60	483	15.2
PZ-5	12,700	0.37	59.6	0.73	1,060	20.8
PZ-6	6,760	ND	ND	0.66	1,060	14.4
PZ-7	10,700	ND	ND	0.59	429	15.4
PZ-8	9,900	0.39	88.7	0.82	491	21.9
PZ-8Dup	13,200	ND	100	0.99	627	28.3
PZ-10	11,000	ND	61.5	0.62	1,310	16.9
PZ-11	4,950	ND	ND	0.24	1,140	9.98
PZ-13	7,930	ND	122	1.13	1,160	10.6

Sample ID	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)
Site Background	13.9	16.9	27,800	11.8	3,700	617
RBC	470	310	2,500	400	--	180
PZ-3	5.72	7.81	25,700	15.8	1,420	143
PZ-4	6.47	8.59	15,900	ND	2,130	147
PZ-5	9.98	11.8	16,900	10.5	2,090	467
PZ-6	5.09	7.36	14,400	ND	965	118
PZ-7	7.27	8.03	14,700	ND	1,890	322
PZ-8	11.4	9.72	18,700	22.6	1,160	1,100
PZ-8Dup	18.7	14.1	25,400	12.30	1,510	1,320
PZ-10	6.72	6.96	14,200	9.64	1,520	277
PZ-11	3.43	4.74	8,880	ND	1,050	149
PZ-13	19.9	7.15	12,600	16.40	803	1,080

**Table 7-34 (Continued)**  
**Inorganics Detected in Site Wide Subsurface Soil Samples (0 to 2 ft bgs)**

Sample ID	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background	17.9	624	--	933	25.8	46.3
RBC	160	--	39	--	55	2,300
PZ-3	6.53	494	ND	453	44.40	29.40
PZ-4	6.59	468	ND	408	35.60	21.00
PZ-5	9.16	582	ND	489	36.90	50
PZ-6	4.83	330	ND	407	28.10	17.00
PZ-7	7.17	563	ND	423	31.60	22.90
PZ-8	9.81	529	ND	415	42.10	30
PZ-8DUP	13.0	668	12.7	420	62.30	34.60
PZ-10	7.88	530	ND	456	31.50	26.20
PZ-11	3.57	461	ND	335	18.40	24.30
PZ-13	6.16	728	ND	413	23.70	31.70

-- No value available.

ND Not detected.

RBC USEPA Region III residential risk-based concentration (RBC) value.

**Table 7-35**  
**Organics Detected in Site Wide Subsurface Soil Samples (0 to 2 ft bgs)**

Sample ID	Bis(2-ethylhexyl)phthalate (µg/g)	DDE (µg/g)	Di-n-butylphthalate (µg/g)
RBC	46	1.9	--
PZ-3	0.34	ND	ND
PZ-4	1.00	ND	ND
PZ-5	ND	ND	ND
PZ-6	ND	ND	ND
PZ-7	ND	ND	ND
PZ-8	0.42	0.03	3.50
PZ-8Dup	0.42	ND	3.80
PZ-10	ND	ND	ND
PZ-11	ND	ND	ND
PZ-13	0.49	ND	ND

-- No value available.

ND Not detected.

RBC USEPA Region III industrial risk-based concentration (RBC) values.

**Table 7-36**  
**Inorganics Detected in Site Wide Subsurface Soil Samples (2 ft bgs to Water Table)**

Sample ID	Depth bgs (ft)	Aluminum (µg/g)	Antimony (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)
Site Background		18,200	ND	73.8	1.02	454
RBC		7,800	3.1	550	0.15	--
PZ-3	5	9,880	ND	ND	0.37	255
	12	1,490	ND	ND	ND	ND
PZ-4	5	2,640	ND	ND	0.45	156
	7	7,280	ND	54.8	0.84	1,090
PZ-4Dup	7	9,860	ND	57.0	0.35	1,220
PZ-5	5	15,400	ND	ND	0.72	691
	10	6,210	ND	ND	0.29	335
PZ-6	20	6,180	ND	ND	0.86	539
	25	3,460	ND	ND	0.27	285
PZ-7	5	21,900	0.42	59.6	0.82	667
	10	5,240	ND	ND	0.37	211
PZ-8	5	8,540	ND	ND	0.59	374
	10	5,970	ND	ND	0.58	338
PZ-9	5	6,790	ND	ND	0.51	307
	10	15,100	ND	52.5	0.85	874
	14	5,010	ND	ND	0.40	420
PZ-10	5	6,070	ND	ND	0.46	225
	10	5,080	ND	ND	0.49	358
PZ-11	10	4,580	ND	ND	0.55	243
PZ-11Dup	10	4,440	ND	ND	0.65	248
PZ-13	10	7,060	ND	60.1	0.84	747
	15	5,720	ND	55.0	0.52	1,050

**Table 7-36 (Continued)**  
**Inorganics Detected in Site Wide Subsurface Soil Samples (2-ft to Water Table)**

Sample ID	Depth bgs (ft)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)	Lead (µg/g)
Site Background		25.0	13.9	16.9	27,800	11.8
RBC		39	470	310	2,500	400
PZ-3	5	27.3	5.51	9.42	16,000	ND
	12	5.26	ND	2.04	1,490	ND
PZ-4	5	4.99	3.84	2.62	6,270	ND
	7	20.3	16.8	19.5	11,100	ND
PZ-4Dup	7	28.5	18.6	24.6	9,730	11.3
PZ-5	5	24.6	15.8	10.5	24,400	12.2
	10	15.8	3.37	3.55	4,850	ND
PZ-6	20	11.7	3.32	6.93	6,080	ND
	25	13.2	4.35	5.93	3,060	ND
PZ-7	5	26.6	12.2	11.6	22,000	10.5
	10	8.64	2.60	3.27	9,110	ND
PZ-8	5	30.1	24.0	19.5	25,100	10.8
	10	26.9	23.7	14.1	25,200	ND
PZ-9	5	25.4	13.9	12.3	21,700	ND
	10	39.4	17.4	27.0	42,100	12.7
	14	27.8	17.7	12.5	23,600	ND
PZ-10	5	36.6	16.9	12.2	23,700	ND
	10	26.9	32.1	17.1	21,700	ND
PZ-11	10	20.0	19.2	11.0	10,800	ND
PZ-11Dup	10	18.8	17.9	12.4	9,180	ND
PZ-13	10	5.89	5.61	13.4	9,430	ND
	15	7.90	4.06	10.4	12,100	ND



**Table 7-36 (Continued)**  
**Inorganics Detected in Site Wide Subsurface Soil Samples (2-ft to Water Table)**

Sample ID	Depth bgs (ft)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Selenium (µg/g)
Site Background		3,700	617	17.9	624	--
RBC		--	180	160	--	39
PZ-3	5	1,430	78.8	6.47	360	ND
	12	280	11.7	ND	ND	ND
PZ-4	5	429	119	ND	ND	ND
	7	3,240	141	22.2	561	ND
PZ-4Dup	7	3,950	108	24.6	752	ND
PZ-5	5	2,960	440	12.9	749	20.4
	10	1,010	128	7.33	458	ND
PZ-6	20	1,060	31.3	6.52	269	ND
	25	738	26.3	4.90	271	ND
PZ-7	5	2,610	453	12.7	852	ND
	10	522	116	2.84	206	ND
PZ-8	5	1,430	987	18.1	530	ND
	10	1,210	1,520	12.9	452	14.7
PZ-9	5	1,110	370	9.90	390	12.0
	10	2,340	334	16.3	895	25.2
	14	1,370	209	8.81	572	15.9
PZ-10	5	1,240	595	9.78	402	ND
	10	1,730	1,350	11.9	559	13.7
PZ-11	10	1,090	119	7.55	473	ND
PZ-11Dup	10	918	111	6.77	440	ND
PZ-13	10	1,060	68.3	3.5	933	ND
	15	886	36.0	2.76	672	ND

**Table 7-36 (Continued)**  
**Inorganics Detected in Site Wide Subsurface Soil Samples (2-ft to Water Table)**

Sample ID	Depth bgs (ft)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background		933	25.8	46.3
RBC		--	55	2,300
PZ-3	5	401	36.4	17.1
	12	345	7.68	ND
PZ-4	5	334	11.8	ND
	7	372	35.4	52.5
PZ-4Dup	7	396	47.4	31.7
PZ-5	5	377	47.0	37.2
	10	344	13.4	13.1
PZ-6	20	511	21.5	20.8
	25	387	13.4	19.5
PZ-7	5	341	51.5	38.8
	10	309	11.9	9.07
PZ-8	5	308	62.8	22.8
	10	340	69.2	19.1
PZ-9	5	424	58.4	17.3
	10	506	103	36.3
	14	480	54.8	19.3
PZ-10	5	359	72.0	20.8
	10	522	57.0	24.1
PZ-11	10	355	48.4	16.4
PZ-11Dup	10	414	43.0	15.1
PZ-13	10	370	23.0	17.1
	15	431	7.68	ND

-- No value available.

ND Not detected.

RBC USEPA Region III residential risk-based concentration (RBC) values.

**Table 7-37**  
**Organics Detected in Site Wide Subsurface Soil Samples (2 ft bgs to Water Table)**

Sample ID	Depth bgs (ft)	Acetone (µg/g)	Benzo(a)-anthracene (µg/g)	Benzo(a)-pyrene (µg/g)	Benzo(b)-fluoranthene (µg/g)	Benzo(k)-fluoranthene (µg/g)
RBC		780	0.88	0.088	0.88	8.8
PZ-3	5	ND	ND	ND	ND	ND
	12	ND	ND	ND	ND	ND
PZ-4	5	ND	ND	ND	ND	ND
	7	ND	ND	ND	ND	ND
PZ-5	5	ND	ND	ND	ND	ND
	10	ND	ND	ND	ND	ND
PZ-6	20	ND	ND	ND	ND	ND
	25	ND	ND	ND	ND	ND
PZ-7	5	ND	ND	ND	ND	ND
	10	ND	ND	ND	ND	ND
PZ-8	5	ND	ND	ND	ND	ND
	10	ND	ND	ND	ND	ND
PZ-9	5	ND	ND	ND	ND	ND
	10	ND	0.33	0.31	0.24	0.27
	14	0.02	ND	ND	ND	ND
PZ-10	5	ND	ND	ND	ND	ND
	10	0.01	ND	ND	ND	ND
PZ-11	10	0.02	ND	ND	ND	ND
PZ-11Dup	10	0.02	ND	ND	ND	ND
PZ-13	10	ND	ND	ND	ND	ND
	15	ND	ND	ND	ND	ND

**Table 7-37 (Continued)**  
**Organics Detected in Site Wide Subsurface Soil Samples (2 ft bgs to Water Table)**

Sample ID	Depth bgs (ft)	Bis(2-ethylhexyl) phthalate (µg/g)	Chrysene (µg/g)	DDT (µg/g)	Di-n-butylphthalate (µg/g)	Fluoranthene (µg/g)
RBC		46	88	1.9	--	310
PZ-3	5	0.20	ND	ND	ND	ND
	12	0.67	ND	ND	2.60	ND
PZ-4	5	0.38	ND	ND	ND	ND
	7	ND	ND	ND	ND	ND
PZ-5	5	ND	ND	ND	ND	ND
	10	0.24	ND	0.01	ND	ND
PZ-6	20	ND	ND	ND	ND	ND
	25	ND	ND	ND	ND	ND
PZ-7	5	ND	ND	ND	ND	ND
	10	ND	ND	0.03	ND	ND
PZ-8	5	ND	ND	ND	ND	ND
	10	0.40	ND	ND	3.30	ND
PZ-9	5	ND	ND	ND	ND	ND
	10	ND	0.33	ND	ND	0.67
	14	ND	ND	ND	ND	ND
PZ-10	5	0.31	ND	ND	ND	ND
	10	0.35	ND	ND	ND	ND
PZ-11	10	0.45	ND	ND	ND	ND
PZ-11Dup	10	0.89	ND	ND	0.89	ND
PZ-13	10	ND	ND	ND	ND	ND
	15	0.30	ND	ND	ND	ND

**Table 7-37 (Continued)**  
**Organics Detected in Site Wide Subsurface Soil Samples (2 ft to Water Table)**

Sample ID	Depth bgs (ft)	Indeno(1,2,3-cd)pyrene (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)
RBC		0.88	230 <sup>a</sup>	230
PZ-3	5	ND	ND	ND
	12	ND	ND	ND
PZ-4	5	ND	ND	ND
	7	ND	ND	ND
PZ-5	5	ND	ND	ND
	10	ND	ND	ND
PZ-6	20	ND	ND	ND
	25	ND	ND	ND
PZ-7	5	ND	ND	ND
	10	ND	ND	ND
PZ-8	5	ND	ND	ND
	10	ND	ND	ND
PZ-9	5	ND	ND	ND
	10	0.21	0.23	0.57
	14	ND	ND	ND
PZ-10	5	ND	ND	ND
	10	ND	ND	ND
PZ-11	10	ND	ND	ND
PZ-11Dup	10	ND	ND	ND
PZ-13	10	ND	ND	ND
	15	ND	ND	ND

<sup>a</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PHAs) lacking RBCs.

-- No value available.

ND Not detected.

RBC USEPA Region III industrial risk-based concentration (RBC) values.

**Table 7-38**  
**Inorganics Detected in Sediment Samples Collected Site Wide**

Sample ID	Aluminum (µg/g)	Barium (µg/g)	Beryllium (µg/g)	Calcium (µg/g)	Chromium (µg/g)	Cobalt (µg/g)	Copper (µg/g)	Iron (µg/g)
Site Background	15,200	175	1.26	6,000	30.1	20.7	41.8	34,200
ER-L	--	--	--	--	81	--	34	--
RISD1	11,500	ND	0.725	1,460	17.6	10.1	24.5	29,900
RISD2	14,200	162	1.02	3,100	22.5	19.3	40.3	26,500
RISD3	2,650	ND	0.487	384	36.8	9.84	6.5	36,100
RISD3DUP	1,850	ND	ND	314	20.8	7.74	4.9	17,900
RISD4	9,390	89.7	0.743	2,070	19.6	11.4	18	22,200
RISD5	20,200	ND	1.41	3,560	32.5	19.3	46.3	28,100
RISD6	20,000	ND	1.51	4,160	34.5	25.2	62.2	36,900
RISD6DUP	12,700	ND	1.19	3,320	25.3	19.5	48.1	28,800
RISD22	6,760	ND	ND	1,250	25.4	10.1	14.9	18,900
RISD23	14,700	ND	1.18	3,800	79	27.4	35.9	45,100
RISD24	7,210	ND	ND	2,070	25.4	14.8	18.8	19,200
RISD24Dup	6,630	ND	0.615	2,850	25.6	17.4	22.9	20,000
RISD25	2,480	ND	0.309	244	25.6	8.02	5.68	24,200
RISD36	21,200	236	1.67	3,360	32	22.3	46.7	26,200
RISD37	20,900	ND	ND	5,140	40.5	34.2	59.3	39,700
RISD38	1,740	ND	ND	471	11.3	ND	5.27	6,940
RISD39	952	ND	ND	174	12.1	2.68	2.37	6,740
RISD40	11,500	ND	ND	4,840	24.2	16.7	41.4	20,300
RISD41	20,700	ND	ND	8,870	40.2	22.3	54.2	31,100
RISD42	9,090	ND	ND	2,120	27.3	12.6	14	21,300
RISD43	1,020	ND	ND	169	5.03	3.03	2.59	4,310
RISD44	12,600	128	0.516	1,750	18.5	11	22.2	15,300
RISD44Dup	18,800	185	0.891	4,520	29.7	20.9	29.4	30,500
RISD45	8,190	ND	0.62	1,510	13.8	8.39	11.8	13,000

**Table 7-38 (Continued)**  
**Inorganics Detected in Sediment Samples Collected Site Wide**

Sample ID	Lead (µg/g)	Magnesium (µg/g)	Manganese (µg/g)	Nickel (µg/g)	Potassium (µg/g)	Sodium (µg/g)	Vanadium (µg/g)	Zinc (µg/g)
Site Background	42.2	3,470	1,690	30.0	2,120	1,710	52.5	157
ER-L	46.7	--	--	20.9	--	--	--	150
RISD1	48.3	1,420	249	13.7	955	791	39.5	104
RISD2	63.6	2,090	403	20.5	1,020	1,570	46.1	249
RISD3	ND	508	629	9.12	246	414	109	38.5
RISD3Dup	ND	432	599	4.75	244	356	44.8	32.8
RISD4	15.1	1,550	1,200	10.6	847	895	42.3	72.1
RISD5	60	3,330	360	28.8	2,020	1,920	57.1	232
RISD6	75	3,480	608	30.5	1,940	1,570	63.3	243
RISD6Dup	63.3	2,660	483	24.5	1,190	1,420	46.4	236
RISD22	16.9	1,160	354	9.16	599	490	49.3	45.9
RISD23	ND	2,740	749	22.5	1,270	1,570	121	126
RISD24	18.4	1,440	357	19.6	781	878	52.3	68.3
RISD24Dup	ND	1,570	449	16.2	666	1,120	62.1	83.5
RISD25	ND	434	222	5.29	171	326	64	32.4
RISD36	50.6	3,120	712	24.5	1,410	1,650	72.7	188
RISD37	55.9	3,750	985	35.8	1,810	1,880	83.3	222
RISD38	ND	397	234	3.56	264	531	15.5	26.6
RISD39	ND	224	277	ND	ND	326	19.8	23.3
RISD40	ND	2,540	461	26.4	1,070	2,790	52.6	117
RISD41	ND	4,090	612	32.3	1,790	2,450	92.3	164
RISD42	19.7	1,740	739	11.6	773	822	53.5	55.1
RISD43	ND	324	197	3.25	199	311	9.79	16.8
RISD44	19.2	2,740	394	13	776	689	49.5	83
RISD44Dup	40.9	3,830	977	21.4	1,260	1,470	84.8	177
RISD45	17.1	1,640	351	8.81	567	794	36.6	69.5

ND Not detected.

-- Not Available

ER-L Effects Range Low.

RISD 46 and 47 were not analyzed for inorganics.

**Table 7-39**  
**Organics Detected in Sediment Samples Collected Site Wide**

Sample ID	1-Methylnaphthalene (µg/g)	2-Methylnaphthalene (µg/g)	Acenaphthene (µg/g)	Acenaphthalene (µg/g)	Acetone (µg/g)	Alpha-chlordane (µg/g)	Anthracene (µg/g)	Benzo(a)anthracene (µg/g)	Benzo(a)pyrene (µg/g)	Benzo(b)fluoranthene (µg/g)
ER-L	230*	230*	470	—	760	—	2,300	0.88	0.088	0.88
RISD1	ND	0.339	1.1	ND	ND	0.008	0.186	ND	0.146	0.176
RISD2	ND	0.51	2.71	ND	0.11	ND	0.041	0.045	0.205	0.176
RISD3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD3Dup	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD4	0.272	ND	0.639	ND	ND	ND	0.016	0.006	0.039	ND
RISD5	ND	0.594	ND	ND	0.04	ND	0.038	0.035	0.061	0.084
RISD6	ND	ND	ND	ND	0.08	ND	ND	0.027	0.043	0.067
RISD6Dup	ND	ND	ND	ND	0.06	ND	ND	0.038	0.063	0.103
RISD22	ND	ND	0.888	ND	ND	ND	0.116	0.032	0.082	0.072
RISD23	ND	ND	1.54	ND	0.09	ND	0.15	0.074	0.169	0.211
RISD24	ND	ND	0.969	0.82	ND	ND	0.719	ND	0.16	ND
RISD24Dup	ND	13.7	ND	0.596	ND	ND	ND	0.01	0.016	0.029
RISD25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD36	1.1	ND	2.11	ND	ND	ND	0.493	ND	0.126	0.342
RISD37	0.66	ND	3.09	ND	ND	ND	0.158	0.116	0.173	0.21
RISD38	ND	ND	ND	ND	ND	ND	0.01	ND	0.039	ND
RISD39	ND	ND	ND	ND	ND	ND	0.012	0.007	0.01	0.009
RISD40	0.871	ND	ND	1.15	ND	ND	0.076	ND	0.222	0.214
RISD41	1.26	ND	ND	ND	0.08	ND	0.377	0.026	0.126	ND
RISD42	ND	ND	1.15	ND	0.03	ND	0.02	0.015	0.045	0.027
RISD43	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD44	ND	ND	ND	ND		ND	0.036	0.006	0.008	0.013
RISD44Dup	ND	ND	1.32	ND	0.04	ND	0.114	.497	0.49	0.369
RISD45	ND	ND	ND	ND	ND	ND	0.077	0.008	0.014	0.023



**Table 7-39 (Continued)**  
**Organics Detected in Sediment Samples Collected Site Wide**

Sample ID	Benzo(g,h,i) perylene (µg/g)	Benzo(k) fluoranthene (µg/g)	Benzoic Acid (µg/g)	Bis(2-ethyl hexyl)phthalate (µg/g)	Chrysene (µg/g)	Chlordane (µg/g)	DDD (µg/g)	DDE (µg/g)	Dibenzo(a,h) anthracene (µg/g)	Diethyl phthalate (µg/g)
ER-L	230 <sup>a</sup>	8.8	31,000	46	88	0.49	2.7	1.9	0.088	6,300
RISD1	ND	0.09	ND	ND	ND	0.095	ND	ND	0.02	ND
RISD2	0.159	0.087	ND	ND	ND	0.084	ND	ND	0.035	ND
RISD3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD3Dup	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD4	ND	0.01	ND	0.46	ND	ND	ND	ND	ND	1.9
RISD5	0.048	0.038	ND	0.65	ND	ND	ND	ND	ND	ND
RISD6	0.126	0.026	ND	ND	ND	ND	ND	ND	ND	ND
RISD6Dup	0.064	0.037	ND	ND	ND	ND	ND	ND	ND	ND
RISD22	0.022	0.033	ND	ND	ND	ND	ND	ND	0.016	ND
RISD23	0.144	0.087	ND	ND	ND	ND	ND	ND	0.026	ND
RISD24	0.03	ND	ND	ND	0.037	ND	ND	ND	ND	ND
RISD24Dup	0.025	0.012	ND	ND	ND	ND	ND	ND	ND	ND
RISD25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD36	0.141	0.143	ND	ND	0.463	ND	ND	ND	ND	ND
RISD37	0.09	0.08	ND	ND	0.044	ND	ND	ND	0.022	ND
RISD38	0.031	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD39	0.011	0.004	ND	0.26	ND	ND	ND	ND	ND	ND
RISD40	3.43	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD41	ND	0.043	ND	ND	ND	ND	ND	ND	ND	ND
RISD42	0.115	0.01	ND	ND	0.018	ND	ND	0.016	ND	ND
RISD43	ND	ND	ND	0.22	ND	ND	ND	ND	ND	ND
RISD44	ND	0.006	3.7	ND	ND	ND	ND	ND	ND	ND
RISD44Dup	0.608	0.195	4.4	ND	0.055	ND	ND	ND	ND	ND
RISD45	ND	0.01	ND	ND	ND	ND	ND	ND	ND	ND

**Table 7-39 (Continued)**  
**Organics Detected in Sediment Samples Collected Site Wide**

Sample ID	Fluoranthene (µg/g)	Fluorene (µg/g)	Gamma- chlordane (µg/g)	Indeno(1,2,3- cd)pyrene (µg/g)	Naphthalene (µg/g)	PCB-1260 (µg/g)	Phenanthrene (µg/g)	Pyrene (µg/g)	TPH, as Diesel (µg/g)
ER-L	310	310	--	0.88	310	0.083 <sup>b</sup>	230 <sup>a</sup>	230	--
RISD1	0.282	0.082	0.011	ND	ND	ND	0.122	0.554	ND
RISD2	0.207	ND	0.012	0.099	ND	0.055	ND	0.278	ND
RISD3	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD3Dup	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD4	0.024	ND	ND	0.008	ND	ND	ND	0.023	23.9
RISD5	0.112	0.19	ND	0.046	ND	ND	ND	0.143	ND
RISD6	0.089	ND	ND	0.027	ND	ND	ND	0.145	ND
RISD6Dup	0.131	0.162	ND	0.049	ND	ND	ND	0.24	ND
RISD22	0.067	ND	ND	0.501	0.249	ND	0.797	0.102	ND
RISD23	0.237	ND	ND	0.033	ND	ND	0.304	0.311	43
RISD24	0.194	ND	ND	ND	0.342	ND	22.9	0.32	ND
RISD24Dup	0.039	2.94	ND	0.013	20.1	ND	0.191	1.03	ND
RISD25	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD35	0.768	0.313	ND	0.227	0.38	0.043	0.68	0.955	ND
RISD36	1.01	ND	ND	0.071	0.88	ND	0.697	1.17	ND
RISD37	0.33	ND	ND	0.861	1.12	ND	ND	0.595	ND
RISD38	0.052	ND	ND	0.023	ND	ND	ND	0.116	ND
RISD39	0.015	ND	ND	0.008	ND	ND	ND	0.011	ND
RISD40	0.246	0.229	ND	0.639	ND	ND	ND	0.18	ND
RISD41	0.104	ND	ND	ND	ND	ND	0.326	ND	ND
RISD42	0.029	ND	ND	0.092	2.92	ND	0.884	ND	38.1
RISD43	ND	ND	ND	ND	ND	ND	ND	ND	ND
RISD44	0.019	0.496	ND	0.01	0.726	ND	ND	0.402	27.7
RISD44Dup	0.955	ND	ND	0.636	ND	ND	1.65	0.852	ND
RISD45	0.043	ND	ND	0.019	0.514	ND	0.14	0.069	ND

<sup>a</sup> The RBC for pyrene was used as a surrogate for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.

<sup>b</sup> Value is for carcinogenic PCBs.

-- No value available

ER-L Effects Range-Low, Long and Morgan, 1990.

ND Not detected.

No organics were detected in RISD 46 and 47.

**Table 7-40**  
**Inorganics Detected in Surface Water Samples Collected Site Wide**

Sample ID	Aluminum (µg/L)	Arsenic (µg/L)	Barium (µg/L)	Cadmium (µg/L)	Calcium (µg/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)
Site Background	1,930	—	41.8	—	22,200	10.8	ND	2,510	1.9
RBC	3,700	0.045	260	1.8	—	18	—	1,100	—
RISW1	4,540	ND	85.4	0.2	15,200	ND	ND	7,460	7.9
RISW2	1,930	ND	61.7	ND	15,700	ND	ND	3,750	3.5
RISW3	1,530	ND	34.3	ND	15,200	ND	7.9	1,760	1.7
RISW3Dup	1,880	ND	35.6	ND	15,100	ND	ND	1,870	1.5
RISW4	1,740	ND	47.5	ND	21,200	ND	ND	5,240	2.2
RISW5	1,500	ND	46.3	ND	17,500	ND	ND	2,800	4.0
RISW6	1,520	ND	55.1	ND	16,600	ND	ND	3,000	4.2
RISW6Dup	1,330	ND	57.5	ND	17,400	ND	ND	3,070	4.3
RISW22	1,090	ND	36.6	ND	18,400	ND	ND	1,410	1.3
RISW23	732	ND	33.8	ND	18,000	ND	ND	1,360	1.1
RISW24	595	ND	31.2	ND	15,700	ND	ND	1,140	1.4
RISW24Dup	800	ND	32.6	ND	15,800	ND	ND	1,500	1.6
RISW25	3,070	ND	38.8	ND	14,300	ND	5.1	2,130	1.9
RISW36	8,960	1.6	56.4	ND	5,140	10.5	6.8	8,320	5.7
RISW37	9,230	1.2	53.6	ND	5,760	ND	6.7	8,190	5.3
RISW38	2,890	ND	46.1	ND	16,100	ND	ND	4,210	3.0
RISW39	5,510	ND	58.4	0.1	15,200	ND	9.9	6,360	5.6
RISW40	636	ND	25.8	ND	14,100	ND	ND	1,520	1.1
RISW41	116	ND	ND	ND	9,070	ND	ND	584	ND
RISW42	215	ND	ND	ND	6,260	ND	ND	930	ND
RISW43	4,040	1	36.4	ND	10,400	ND	ND	3,920	1.8
RISW44	29,900	1.9	106	0.1	4,780	33.6	17.2	28,900	11.4
RISW44Dup	37,600	ND	116	ND	4,770	36.8	18	31,000	9.1
RISW45	32,500	2.5	118	0.1	4,500	38.1	18.9	32,900	16

**Table 7-40 (Continued)**  
**Inorganics Detected in Surface Water Samples Collected Site Wide**

Sample ID	Magnesium (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Potassium (µg/L)	Selenium (µg/L)	Sodium (µg/L)	Thallium (µg/L)	Vanadium (µg/L)	Zinc (µg/L)
Site Background	7,500	303	ND	3,670	--	16,500	--	ND	ND
RBC	--	18	--	--	18	--	--	26	1,100
RISW1	4,510	1,290	ND	3,600	ND	12,300	ND	13.3	31.8
RISW2	4,900	1,020	ND	3,710	ND	13,200	ND	ND	ND
RISW3	4,970	211	ND	3,920	ND	11,200	ND	ND	24.7
RISW3Dup	5,040	222	ND	3,450	ND	11,500	ND	ND	ND
RISW4	7,840	1,620	ND	3,830	ND	21,900	ND	ND	ND
RISW5	5,790	237	ND	4,510	ND	13,800	ND	ND	ND
RISW6	5,360	425	ND	4,370	ND	12,700	ND	ND	25.9
RISW6Dup	5,690	4,450	ND	4,670	ND	13,800	ND	ND	32.5
RISW22	5,570	363	ND	3,900	ND	15,400	ND	ND	ND
RISW23	5,470	324	ND	3,810	ND	15,000	ND	ND	ND
RISW24	5,720	186	ND	4,260	2.2	20,500	ND	ND	ND
RISW24Dup	5,800	189	ND	4,180	ND	20,800	ND	ND	ND
RISW25	4,670	123	ND	3,990	ND	9,930	ND	ND	29.9
RISW36	2,350	145	ND	3,340	ND	2,140	ND	17.9	28.9
RISW37	2,640	225	ND	3,680	ND	2,830	ND	19.9	24.4
RISW38	5,960	677	ND	4,650	2.5	16,500	ND	ND	ND
RISW39	5,320	346	ND	3,640	ND	10,100	ND	14.5	24.7
RISW40	5,130	259	ND	4,810	ND	15,300	ND	ND	ND
RISW41	3,510	49.1	ND	5,130	ND	7,430	ND	ND	ND
RISW42	2,950	87.9	ND	4,070	ND	4,280	ND	ND	ND
RISW43	3,810	244	ND	3,440	ND	6,150	ND	ND	ND
RISW44	5,100	712	17.0	5,930	ND	2,090	0.1	61.5	75.8
RISW44Dup	5,540	721	17.7	6,760	ND	2,130	ND	69	81.9
RISW45	5,400	755	ND	5,270	ND	2,120	0.3	68.5	65.5

-- No value available.

ND Not detected.

RBC USEPA Region III residential risk-based concentration (RBC) value for groundwater.

**Table 7-41**  
**Organics Detected in Surface Water Samples Collected Site Wide**

Compound	Acetone (µg/L)	Bis(2-ethylhexyl) phthalate (µg/L)	Di-n-butylphthalate (µg/L)	Fluoranthene (µg/L)
RBC	370	4.8	--	150
RISW2	ND	5.5	ND	ND
RISW3	ND	ND	2.9	ND
RISW3Dup	ND	2.4	ND	ND
RISW6	ND	2.8	ND	ND
RISW9	ND	25.0	ND	ND
RISW24Dup	ND	ND	ND	0.025
RISW25	ND	ND	3.1	ND
RISW26	24.0	ND	ND	ND
RISW27	11.0	ND	ND	0.023
RISW28	13.0	ND	ND	0.026
RISW29	22.0	ND	ND	ND
RISW33	10.0	ND	ND	ND
RISW38	11.0	ND	ND	ND
RISW44	12.0	ND	ND	ND

-- No values available.

ND Not detected.

RBC USEPA Region III industrial risk-based concentration (RBC) values for groundwater.

**Table 7-42**  
**Compounds Detected in Site Wide Fish Tissue Samples**

Sample ID	Location	alpha Chlordane (µg/kg)	DDD (µg/kg)	DDE (µg/kg)	gamma Chlordane (µg/kg)	Heptachlor (µg/kg)	Mercury (µg/kg)	PCB-1260 (µg/kg)
RBC		2.4	13	9.3	2.4	7	41	0.41
C.FISH-1W	Pond	ND	ND	7.32	ND	ND	ND	51.5
C.FISH-2W	Pond	ND	ND	3.51	ND	ND	ND	ND
CARP-1W	Ditch	5.18	113	88.1	2.94	ND	ND	602
CARP-2W	Ditch	9.97	325	167	5.85	ND	ND	962
CARP-3W	Ditch	3.26	75.9	61.2	2.19	ND	ND	379
CRAPPIE-1W	Ditch	ND	ND	84.3	ND	ND	0.1	447
CRAPPIE-2W	Ditch	ND	ND	33.6	ND	ND	0.134	201
CRAPPIE-3W	Ditch	ND	ND	49	ND	ND	0.207	242
CRAPPIE-4W	Ditch	ND	ND	52.8	ND	ND	0.139	264
CRAPPIE-5W	Ditch	ND	ND	45.1	ND	ND	0.175	264
EEL-1W	Ditch	3.39	ND	23.7	1.35	ND	ND	158
EEL-2W	Ditch	5.68	ND	34.6	1.95	ND	ND	274
EEL-3W	Ditch	8.25	ND	25.1	2.31	ND	0.062	1090
EEL-4W	Ditch	7.15	82.3	54.6	2.05	ND	0.054	783
S.FISH-1W	Ditch	ND	ND	20.9	ND	ND	ND	149
S.FISH-1W	Marumsco	ND	ND	15.9	ND	ND	ND	126
S.FISH-2W	Ditch	ND	ND	14.4	ND	ND	ND	107
S.FISH-2W	Marumsco	ND	ND	14.5	ND	1.42	ND	105
S.FISH-3W	Ditch	ND	ND	53.1	ND	ND	ND	310
S.FISH-3W	Marumsco	ND	ND	14	ND	ND	ND	97.6
S.FISH-4W	Ditch	ND	ND	52.3	ND	ND	ND	620
S.FISH-4W	Marumsco	ND	ND	30.2	ND	ND	ND	110
S.FISH-5W	Ditch	ND	ND	73.5	ND	ND	0.067	411
S.FISH-5W	Marumsco	ND	ND	ND	ND	ND	ND	115
WPERCH-1W	Marumsco	14.7	ND	34.9	ND	ND	0.05	267
WPERCH-1W	Pond	ND	ND	11.4	ND	ND	0.086	58.4
WPERCH-2W	Marumsco	13.2	30.9	30.9	ND	ND	0.026	227
WPERCH-2W	Pond	ND	ND	12.3	ND	ND	0.059	64.2
WPERCH-3W	Marumsco	12.3	ND	28.6	ND	ND	0.025	234
WPERCH-3W	Pond	ND	ND	9.76	ND	ND	0.083	53
WPERCH-4W	Marumsco	16.3	ND	38.3	ND	ND	0.039	277
WPERCH-4W	Pond	ND	ND	ND	ND	ND	0.08	ND
WPERCH-5W	Marumsco	12	ND	29.1	ND	ND	0.029	221
WPERCH-5W	Pond	ND	ND	12.4	ND	ND	0.078	61.9

ND Not detected.

RBC USEPA Region III residential risk-based concentration (RBC) values.

**Table 7-43**  
**Results of Live Clam Analysis**

Location	Date	Sample	Compound	Reported Value	Corrected Value <sup>1</sup>	Units
Control	08/30/95	CONTROL	4,4'-DDD	0.667		UG/KG-WET
Control	08/30/95	CONTROL	4,4'-DDE	6.39		UG/KG-WET
Control	08/30/95	CONTROL	4,4'-DDT	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Acenaphthene, Tiss	0.386		UG/G-WET
Control	08/30/95	CONTROL	Acenaphthylene, Tiss	0.095		UG/G-WET
Control	08/30/95	CONTROL	Aldrin, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	alpha-BHC, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	alpha-Chlordane, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Anthracene, Tiss	0.007		UG/G-WET
Control	08/30/95	CONTROL	Benzo(a)anthracene, Tiss	0.001		UG/G-WET
Control	08/30/95	CONTROL	Benzo(a)pyrene, Tiss	0.0009		UG/G-WET
Control	08/30/95	CONTROL	Benzo(b)fluoranthene, Tiss	0.002		UG/G-WET
Control	08/30/95	CONTROL	Benzo(g,h,i)perylene, Tiss	0.0003		UG/G-WET
Control	08/30/95	CONTROL	Benzo(k)fluoranthene, Tiss	0.0006		UG/G-WET
Control	08/30/95	CONTROL	beta-BHC, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Chrysene, Tiss	0.003		UG/G-WET
Control	08/30/95	CONTROL	delta-BHC, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Dibenz(a,h)anthracene, Tiss	0.0002		UG/G-WET
Control	08/30/95	CONTROL	Dieldrin, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Endosulfan I, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Endosulfan II, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Endosulfan sulfate, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Endrin aldehyde, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Endrin, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Fluoranthene, Tiss	0.008		UG/G-WET
Control	08/30/95	CONTROL	Fluorene, Tiss	0.017		UG/G-WET
Control	08/30/95	CONTROL	gamma-BHC (Lindane), Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	gamma-Chlordane, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Heptachlor epoxide, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Heptachlor, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Indeno(1,2,3-c,d)pyrene, Tiss	0.0002		UG/G-WET
Control	08/30/95	CONTROL	Lead, Tiss	9.76		UG/G-WET
Control	08/30/95	CONTROL	Lipid %	1.4		
Control	08/30/95	CONTROL	Mercury, Tiss	0.019		UG/G-WET
Control	08/30/95	CONTROL	Methoxychlor, Sed, Tiss	0.667		UG/KG-WET
Control	08/30/95	CONTROL	Naphthalene, Tiss	0.04		UG/G-WET
Control	08/30/95	CONTROL	PCB-1016, Tiss	13.3		UG/KG-WET
Control	08/30/95	CONTROL	PCB-1221, Tiss	13.3		UG/KG-WET
Control	08/30/95	CONTROL	PCB-1232, Tiss	13.3		UG/KG-WET
Control	08/30/95	CONTROL	PCB-1242, Tiss	13.3		UG/KG-WET
Control	08/30/95	CONTROL	PCB-1248, Tiss	13.3		UG/KG-WET
Control	08/30/95	CONTROL	PCB-1254, Tiss	13.3		UG/KG-WET
Control	08/30/95	CONTROL	PCB-1260, Tiss	52.9		UG/KG-WET
Control	08/30/95	CONTROL	PCB-5432, Tiss	0.067		UG/G-WET
Control	08/30/95	CONTROL	PCB-5442, Tiss	0.067		UG/G-WET
Control	08/30/95	CONTROL	PCB-5460, Tiss	0.067		UG/G-WET
Control	08/30/95	CONTROL	Phenanthrene, Tiss	0.01		UG/G-WET
Control	08/30/95	CONTROL	Pyrene, Tiss	0.004		UG/G-WET
Control	08/30/95	CONTROL	Toxaphene, Tiss	66.7		UG/KG-WET

**Table 7-43**  
**Results of Live Clam Analysis**

Location	Date	Sample	Compound	Reported Value	Corrected Value <sup>1</sup>	Units
Live-Marumsco/Occ	11/21/94	CLAM-1L	4,4'-DDD	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	4,4'-DDE	4.22	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	4,4'-DDT	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Acenaphthene, Tiss	0.133	0	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Acenaphthylene, Tiss	0.095	0	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Aldrin, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	alpha-BHC, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	alpha-Chlordane, Tiss	8	7.333	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Anthracene, Tiss	0.012	0.005	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Benzo(a)anthracene, Tiss	0.004	0.003	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Benzo(a)pyrene, Tiss	0.001	0.0001	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Benzo(b)fluoranthene, Tiss	0.004	0.002	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Benzo(g,h,i)perylene, Tiss	0.0003	0	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Benzo(k)fluoranthene, Tiss	0.001	0.0004	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	beta-BHC, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Chrysene, Tiss	0.02	0.017	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	delta-BHC, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Dibenz(a,h)anthracene, Tiss	0.0002	0	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Dieldrin, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Endosulfan I, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Endosulfan II, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Endosulfan sulfate, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Endrin aldehyde, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Endrin, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Fluoranthene, Tiss	0.07	0.062	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Fluorene, Tiss	0.217	0.2	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	gamma-BHC (Lindane), Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	gamma-Chlordane, Tiss	3.11	2.443	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Heptachlor epoxide, Tiss	2.01	1.343	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Heptachlor, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Indeno(1,2,3-c,d)pyrene, Tiss	0.0002	0	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Lead, Tiss	9.29	0	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Lipid %	2.2		
Live-Marumsco/Occ	11/21/94	CLAM-1L	Mercury, Tiss	0.02	0.001	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Methoxychlor, Sed, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Naphthalene, Tiss	0.158	0.118	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	PCB-1016, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	PCB-1221, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	PCB-1232, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	PCB-1242, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	PCB-1248, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	PCB-1254, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	PCB-1260, Tiss	44.1	0	UG/KG-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	PCB-5432, Tiss	0.067	0	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	PCB-5442, Tiss	0.067	0	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	PCB-5460, Tiss	0.067	0	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Phenanthrene, Tiss	0.081	0.071	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Pyrene, Tiss	0.089	0.085	UG/G-WET
Live-Marumsco/Occ	11/21/94	CLAM-1L	Toxaphene, Tiss	66.7	0	UG/KG-WET



**Table 7-43**  
**Results of Live Clam Analysis**

Location	Date	Sample	Compound	Reported Value	Corrected Value <sup>1</sup>	Units
Live-Marumsco/Occ	12/05/94	CLAM-2L	4,4'-DDD	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	4,4'-DDE	8.57	2.18	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	4,4'-DDT	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Acenaphthene, Tiss	0.133	0	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Acenaphthylene, Tiss	0.095	0	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Aldrin, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	alpha-BHC, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	alpha-Chlordane, Tiss	6.42	5.753	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Anthracene, Tiss	0.01	0.003	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Benzo(a)anthracene, Tiss	0.003	0.002	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Benzo(a)pyrene, Tiss	0.001	0.0001	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Benzo(b)fluoranthene, Tiss	0.003	0.001	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Benzo(g,h,i)perylene, Tiss	0.002	0.0017	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Benzo(k)fluoranthene, Tiss	0.001	0.0004	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	beta-BHC, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Chrysene, Tiss	0.007	0.004	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	delta-BHC, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Dibenz(a,h)anthracene, Tiss	0.0002	0	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Dieldrin, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Endosulfan I, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Endosulfan II, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Endosulfan sulfate, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Endrin aldehyde, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Endrin, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Fluoranthene, Tiss	0.047	0.039	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Fluorene, Tiss	0.037	0.02	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	gamma-BHC (Lindane), Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	gamma-Chlordane, Tiss	3.67	3.003	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Heptachlor epoxide, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Heptachlor, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Indeno(1,2,3-c,d)pyrene, Tiss	0.002	0.0018	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Lead, Tiss	9.3	0	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Lipid %	1.9		
Live-Marumsco/Occ	12/05/94	CLAM-2L	Mercury, Tiss	0.02	0.001	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Methoxychlor, Sed, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Naphthalene, Tiss	0.04	0	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	PCB-1016, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	PCB-1221, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	PCB-1232, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	PCB-1242, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	PCB-1248, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	PCB-1254, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	PCB-1260, Tiss	81.1	28.2	UG/KG-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	PCB-5432, Tiss	0.067	0	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	PCB-5442, Tiss	0.067	0	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	PCB-5460, Tiss	0.067	0	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Phenanthrene, Tiss	0.092	0.082	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Pyrene, Tiss	0.057	0.053	UG/G-WET
Live-Marumsco/Occ	12/05/94	CLAM-2L	Toxaphene, Tiss	66.7	0	UG/KG-WET

**Table 7-43**  
**Results of Live Clam Analysis**

Location	Date	Sample	Compound	Reported Value	Corrected Value <sup>1</sup>	Units
Live-Marumsco/Occ	12/06/94	CLAM-3L	4,4'-DDD	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	4,4'-DDE	7.63	1.24	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	4,4'-DDT	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Acenaphthene, Tiss	0.133	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Acenaphthylene, Tiss	0.095	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Aldrin, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	alpha-BHC, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	alpha-Chlordane, Tiss	5.66	4.993	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Anthracene, Tiss	0.009	0.002	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Benzo(a)anthracene, Tiss	0.001	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Benzo(a)pyrene, Tiss	0.0004	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Benzo(b)fluoranthene, Tiss	0.001	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Benzo(g,h,i)perylene, Tiss	0.0003	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Benzo(k)fluoranthene, Tiss	0.0005	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	beta-BHC, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Chrysene, Tiss	0.007	0.004	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	delta-BHC, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Dibenz(a,h)anthracene, Tiss	0.0002	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Dieldrin, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Endosulfan I, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Endosulfan II, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Endosulfan sulfate, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Endrin aldehyde, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Endrin, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Fluoranthene, Tiss	0.016	0.008	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Fluorene, Tiss	0.017	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	gamma-BHC (Lindane), Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	gamma-Chlordane, Tiss	1.15	0.483	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Heptachlor epoxide, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Heptachlor, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Indeno(1,2,3-c,d)pyrene, Tiss	0.0002	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Lead, Tiss	9.76	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Lipid %	1.9		
Live-Marumsco/Occ	12/06/94	CLAM-3L	Mercury, Tiss	0.019	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Methoxychlor, Sed, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Naphthalene, Tiss	0.09	0.05	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	PCB-1016, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	PCB-1221, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	PCB-1232, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	PCB-1242, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	PCB-1248, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	PCB-1254, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	PCB-1260, Tiss	67	14.1	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	PCB-5432, Tiss	0.067	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	PCB-5442, Tiss	0.067	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	PCB-5460, Tiss	0.067	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Phenanthrene, Tiss	0.031	0.021	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Pyrene, Tiss	0.014	0.01	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-3L	Toxaphene, Tiss	66.7	0	UG/KG-WET

**Table 7-43**  
**Results of Live Clam Analysis**

Location	Date	Sample	Compound	Reported Value	Corrected Value <sup>1</sup>	Units
Live-Marumsco/Occ	12/06/94	CLAM-4L	4,4'-DDD	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	4,4'-DDE	8.14	1.75	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	4,4'-DDT	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Acenaphthene, Tiss	0.133	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Acenaphthylene, Tiss	0.095	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Aldrin, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	alpha-BHC, Tiss	0.9	0.233	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	alpha-Chlordane, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Anthracene, Tiss	0.008	0.001	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Benzo(a)anthracene, Tiss	0.0007	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Benzo(a)pyrene, Tiss	0.0002	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Benzo(b)fluoranthene, Tiss	0.001	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Benzo(g,h,i)perylene, Tiss	0.0003	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Benzo(k)fluoranthene, Tiss	0.0003	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	beta-BHC, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Chrysene, Tiss	0.011	0.008	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	delta-BHC, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Dibenz(a,h)anthracene, Tiss	0.0002	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Dieldrin, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Endosulfan I, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Endosulfan II, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Endosulfan sulfate, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Endrin aldehyde, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Endrin, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Fluoranthene, Tiss	0.012	0.004	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Fluorene, Tiss	0.017	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	gamma-BHC (Lindane), Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	gamma-Chlordane, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Heptachlor epoxide, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Heptachlor, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Indeno(1,2,3-c,d)pyrene, Tiss	0.0004	0.0002	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Lead, Tiss	9.15	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Lipid %	1.8		
Live-Marumsco/Occ	12/06/94	CLAM-4L	Mercury, Tiss	0.019	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Methoxychlor, Sed, Tiss	0.667	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Naphthalene, Tiss	0.04	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	PCB-1016, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	PCB-1221, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	PCB-1232, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	PCB-1242, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	PCB-1248, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	PCB-1254, Tiss	13.3	0	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	PCB-1260, Tiss	73.8	20.9	UG/KG-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	PCB-5432, Tiss	0.067	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	PCB-5442, Tiss	0.067	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	PCB-5460, Tiss	0.067	0	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Phenanthrene, Tiss	0.022	0.012	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Pyrene, Tiss	0.007	0.003	UG/G-WET
Live-Marumsco/Occ	12/06/94	CLAM-4L	Toxaphene, Tiss	66.7	0	UG/KG-WET

**Table 7-43**  
**Results of Live Clam Analysis**

Location	Date	Sample	Compound	Reported Value	Corrected Value <sup>1</sup>	Units
Live-Main_Ditch	12/06/94	CLAM-5L	4,4'-DDD	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	4,4'-DDE	5.92	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	4,4'-DDT	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Acenaphthene,Tiss	0.133	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Acenaphthylene,Tiss	0.095	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Aldrin,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	alpha-BHC,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	alpha-Chlordane,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Anthracene,Tiss	0.01	0.003	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Benzo(a)anthracene,Tiss	0.001	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Benzo(a)pyrene,Tiss	0.0004	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Benzo(b)fluoranthene,Tiss	0.002	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Benzo(g,h,i)perylene,Tiss	0.0003	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Benzo(k)fluoranthene,Tiss	0.0003	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	beta-BHC,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Chrysene,Tiss	0.003	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	delta-BHC,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Dibenz(a,h)anthracene,Tiss	0.0002	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Dieldrin,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Endosulfan I,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Endosulfan II,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Endosulfan sulfate,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Endrin aldehyde,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Endrin,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Fluoranthene,Tiss	0.023	0.015	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Fluorene,Tiss	0.017	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	gamma-BHC (Lindane),Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	gamma-Chlordane,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Heptachlor epoxide,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Heptachlor,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Indeno(1,2,3-c,d)pyrene,Tiss	0.001	0.0008	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Lead,Tiss	9.17	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Lipid %	2.7		
Live-Main_Ditch	12/06/94	CLAM-5L	Mercury,Tiss	0.02	0.001	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Methoxychlor,Sed,Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Naphthalene,Tiss	0.04	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	PCB-1016,Tiss	13.3	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	PCB-1221,Tiss	13.3	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	PCB-1232,Tiss	13.3	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	PCB-1242,Tiss	13.3	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	PCB-1248,Tiss	13.3	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	PCB-1254,Tiss	13.3	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	PCB-1260,Tiss	42.3	0	UG/KG-WET
Live-Main_Ditch	12/06/94	CLAM-5L	PCB-5432,Tiss	0.067	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	PCB-5442,Tiss	0.067	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	PCB-5460,Tiss	0.067	0	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Phenanthrene,Tiss	0.041	0.031	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Pyrene,Tiss	0.006	0.002	UG/G-WET
Live-Main_Ditch	12/06/94	CLAM-5L	Toxaphene,Tiss	66.7	0	UG/KG-WET

**Table 7-43**  
**Results of Live Clam Analysis**

Location	Date	Sample	Compound	Reported	Corrected	Units
				Value	Value <sup>1</sup>	
Live-Main_Ditch	11/07/94	CLAM-6L	4,4'-DDD	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	4,4'-DDE	8.96	2.57	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	4,4'-DDT	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Acenaphthene, Tiss	0.133	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Acenaphthylene, Tiss	0.095	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Aldrin, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	alpha-BHC, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	alpha-Chlordane, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Anthracene, Tiss	0.007	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Benzo(a)anthracene, Tiss	0.0003	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Benzo(a)pyrene, Tiss	0.0002	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Benzo(b)fluoranthene, Tiss	0.002	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Benzo(g,h,i)perylene, Tiss	0.0003	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Benzo(k)fluoranthene, Tiss	0.0002	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	beta-BHC, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Chrysene, Tiss	0.002	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	delta-BHC, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Dibenz(a,h)anthracene, Tiss	0.0002	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Dieldrin, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Endosulfan I, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Endosulfan II, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Endosulfan sulfate, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Endrin aldehyde, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Endrin, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Fluoranthene, Tiss	0.017	0.009	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Fluorene, Tiss	0.017	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	gamma-BHC (Lindane), Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	gamma-Chlordane, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Heptachlor epoxide, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Heptachlor, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Indeno(1,2,3-c,d)pyrene, Tiss	0.0004	0.0002	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Lead, Tiss	9.79	0.03	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Lipid %	1.8		
Live-Main_Ditch	11/07/94	CLAM-6L	Mercury, Tiss	0.019	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Methoxychlor, Sed, Tiss	0.667	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Naphthalene, Tiss	0.04	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	PCB-1016, Tiss	13.3	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	PCB-1221, Tiss	13.3	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	PCB-1232, Tiss	13.3	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	PCB-1242, Tiss	13.3	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	PCB-1248, Tiss	13.3	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	PCB-1254, Tiss	13.3	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	PCB-1260, Tiss	41.9	0	UG/KG-WET
Live-Main_Ditch	11/07/94	CLAM-6L	PCB-5432, Tiss	0.067	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	PCB-5442, Tiss	0.067	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	PCB-5460, Tiss	0.067	0	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Phenanthrene, Tiss	0.035	0.025	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Pyrene, Tiss	0.013	0.009	UG/G-WET
Live-Main_Ditch	11/07/94	CLAM-6L	Toxaphene, Tiss	66.7	0	UG/KG-WET

**Table 7-43**  
**Results of Live Clam Analysis**

Location	Date	Sample	Compound	Reported Value	Corrected Value <sup>1</sup>	Units
Live-Belmont	12/06/94	CLAM-8L	4,4'-DDD	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	4,4'-DDE	9.52	3.13	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	4,4'-DDT	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Acenaphthene, Tiss	0.133	0	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Acenaphthylene, Tiss	0.095	0	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Aldrin, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	alpha-BHC, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	alpha-Chlordane, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Anthracene, Tiss	0.007	0	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Benzo(a)anthracene, Tiss	0.002	0.001	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Benzo(a)pyrene, Tiss	0.0008	0	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Benzo(b)fluoranthene, Tiss	0.002	0	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Benzo(g,h,i)perylene, Tiss	0.0006	0.0003	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Benzo(k)fluoranthene, Tiss	0.0005	0	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	beta-BHC, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Chrysene, Tiss	0.012	0.009	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	delta-BHC, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Dibenz(a,h)anthracene, Tiss	0.0005	0.0003	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Dieldrin, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Endosulfan I, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Endosulfan II, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Endosulfan sulfate, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Endrin aldehyde, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Endrin, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Fluoranthene, Tiss	0.012	0.004	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Fluorene, Tiss	0.017	0	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	gamma-BHC (Lindane), Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	gamma-Chlordane, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Heptachlor epoxide, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Heptachlor, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Indeno(1,2,3-c,d)pyrene, Tiss	0.0002	0	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Lead, Tiss	9.79	0.03	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Lipid %	2.3		
Live-Belmont	12/06/94	CLAM-8L	Mercury, Tiss	0.019	0	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Methoxychlor, Sed, Tiss	0.667	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	Naphthalene, Tiss	0.04	0	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	PCB-1016, Tiss	13.3	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	PCB-1221, Tiss	13.3	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	PCB-1232, Tiss	13.3	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	PCB-1242, Tiss	13.3	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	PCB-1248, Tiss	13.3	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	PCB-1254, Tiss	13.3	0	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	PCB-1260, Tiss	72.7	19.8	UG/KG-WET
Live-Belmont	12/06/94	CLAM-8L	PCB-5432, Tiss	0.067	0	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	PCB-5442, Tiss	0.067	0	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	PCB-5460, Tiss	0.067	0	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Phenanthrene, Tiss	0.016	0.006	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Pyrene, Tiss	0.025	0.021	UG/G-WET
Live-Belmont	12/06/94	CLAM-8L	Toxaphene, Tiss	66.7	0	UG/KG-WET

**Table 7-43**  
**Results of Live Clam Analysis**

Location	Date	Sample	Compound	Reported Value	Corrected Value <sup>1</sup>	Units
Dead-Main_Ditch	10/26/94	CLAM-7D	4,4'-DDD	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	4,4'-DDE	5.9	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	4,4'-DDT	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Acenaphthene,Tiss	0.133	0	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Acenaphthylene,Tiss	0.095	0	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Aldrin,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	alpha-BHC,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	alpha-Chlordane,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Anthracene,Tiss	0.007	0	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Benzo(a)anthracene,Tiss	0.002	0.001	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Benzo(a)pyrene,Tiss	0.001	0.0001	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Benzo(b)fluoranthene,Tiss	0.003	0.001	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Benzo(g,h,i)perylene,Tiss	0.0004	0.0001	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Benzo(k)fluoranthene,Tiss	0.00008	0	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	beta-BHC,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Chrysene,Tiss	0.003	0	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	delta-BHC,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Dibenz(a,h)anthracene,Tiss	0.001	0.0008	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Dieldrin,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Endosulfan I,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Endosulfan II,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Endosulfan sulfate,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Endrin aldehyde,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Endrin,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Fluoranthene,Tiss	0.011	0.003	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Fluorene,Tiss	0.017	0	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	gamma-BHC (Lindane),Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	gamma-Chlordane,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Heptachlor epoxide,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Heptachlor,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Indeno(1,2,3-c,d)pyrene,Tiss	0.0005	0.0003	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Lead,Tiss	10	0.24	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Lipid %	3.5		
Dead-Main_Ditch	10/26/94	CLAM-7D	Mercury,Tiss	0.019	0	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Methoxychlor,Sed,Tiss	0.667	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Naphthalene,Tiss	0.04	0	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	PCB-1016,Tiss	13.3	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	PCB-1221,Tiss	13.3	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	PCB-1232,Tiss	13.3	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	PCB-1242,Tiss	13.3	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	PCB-1248,Tiss	13.3	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	PCB-1254,Tiss	13.3	0	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	PCB-1260,Tiss	93.6	40.7	UG/KG-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	PCB-5432,Tiss	0.067	0	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	PCB-5442,Tiss	0.067	0	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	PCB-5460,Tiss	0.067	0	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Phenanthrene,Tiss	0.013	0.003	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Pyrene,Tiss	0.024	0.02	UG/G-WET
Dead-Main_Ditch	10/26/94	CLAM-7D	Toxaphene,Tiss	66.7	0	UG/KG-WET

**Section 10.0**  
**Summary of Risk Assessments for**  
**Woodbridge Research Facility of Chemicals for Evaluation**



## 10.0 SUMMARY OF RISK ASSESSMENTS FOR WOODBRIDGE RESEARCH FACILITY OF CHEMICALS FOR EVALUATION

### 10.1 HUMAN HEALTH RISK ASSESSMENTS

Risk assessments were conducted for the four OUs at WRF to evaluate the potential human health effects associated with chemical contamination associated with past activities. Chemicals that were detected in each of the evaluated media were screened against health-based criteria (i.e., RBCs) and background concentrations (for inorganic chemicals that exceeded RBCs) in order to determine which chemicals could potentially be of concern with respect to human health. The detailed HHRAs can be found in the Draft Final FFSS for OU1 (USAEC, 1997a), OU2 and OU4 (USAEC, 1997b), and OU3 (USAEC, 1996a). These detailed Risk Assessments are presented in Appendix A of this RI report.

For each of the OU assessments, potential exposure pathways for current (OU3) and hypothetical future receptors (all OUs) were evaluated. Conservative receptors were evaluated in order to provide baseline worst-case risks associated with exposures at the site. A reasonable maximum exposure (RME) case was evaluated in the Risk Assessments, in order to place a conservative upper-bound on the potential risks, meaning that the risk estimates were unlikely to be underestimated but may very well have been overestimated. The risk estimates calculated for each of the exposure pathways were the upper-bound excess lifetime cancer risks for carcinogenic chemicals and hazard indices for noncarcinogenic chemicals. Cancer risk estimates were compared to USEPA's target risk range for health protectiveness at Superfund sites of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$ , as recommended by USEPA. The potential for adverse noncarcinogenic effects was assessed by comparing the noncarcinogenic hazard indices to a value of one; a hazard index less than one indicates that adverse noncarcinogenic health effects would not be expected to occur. The overall risk results associated with each of the WRF OUs are presented below.

#### 10.1.1 Operable Unit One

The most significant risks associated with exposures to evaluated media at OU1 were associated with ingestion and dermal absorption of chemicals in groundwater by hypothetical future residents. Even though elevated hazard indices were calculated for exposures to chemicals in groundwater, it should be noted that this pathway is considered to be highly unlikely for several reasons. First, residents would not likely reside at WRF, since the facility will be transferred to the USFWS. Second, drinking water is provided by the local water supply, and third, the high iron levels would preclude individuals from installing drinking water wells at OU1. Risks and hazard indices associated with groundwater ingestion for the next most conservative receptor (i.e., a worker) also were calculated, and the risk was lower than the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range, although the hazard index was equal to 2 (due to iron).

Risks associated with exposures to chemicals of potential concern (COPCs) in all other media were within or below the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range for all receptors, while all noncancer hazard indices were lower than one, indicating the noncarcinogenic adverse effects would not be likely to occur.

An evaluation was conducted for chemicals that were determined to be within background concentrations, but that exceeded their respective RBCs. Risks for these chemicals were typically similar in order of magnitude as risks associated with exposures to COPCs. Consequently, eliminating chemicals as COPCs that were within background concentrations, but greater than RBCs, did not significantly alter the conclusions concerning risks associated with exposures to site-related inorganic concentrations.

#### 10.1.2 Operable Unit Three

The most significant risks associated with exposures to evaluated media at OU3 were associated with ingestion of fish by hypothetical future residents. Even though elevated risks were calculated for this receptor, it should be noted that this pathway is considered to be highly unlikely for several reasons. First, residents would not likely reside at WRF, since the facility will be transferred to the USFWS. Second, individuals would not likely fish at OU3 ditches, since there are other areas at WRF with much better fishing (e.g., Belmont and Occoquan Bays, Marumsco Creek, and the pond at WRF). Finally, the ditches do not support great quantities or sizes of fish to allow for significant ingestion exposures. In

addition, the species associated with the greatest risks (i.e., eel) is not a species that would likely be consumed at all.

Risks associated with exposures to COPCs in sediment and surface water at OU3 were within or below the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range for all receptors and both areas, while all noncancer hazard indices were lower than one, indicating the noncarcinogenic adverse effects would not be likely to occur.

An evaluation was conducted for chemicals that were determined to be within background concentrations, but that exceeded their respective RBCs. Risks for these chemicals were typically similar in order of magnitude or lower than risks associated with exposures to COPCs, with the only exception being for groundwater. Consequently, eliminating chemicals as COPCs that were within background concentrations and greater than RBCs did not significantly alter the conclusions concerning risks associated with exposures to site-related inorganic concentrations for most media.

### 10.1.3 Operable Unit Two and Operable Unit Four

The most significant risks associated with exposures to evaluated media at OU2 and OU4 were associated with exposures to PAHs in soil from the PCBs Area grouping, exposures to iron in groundwater from downgradient of the Main Compound, and from ingestion of fish from the Pond and Marumscro Creek. However, the results for exposures to soil and groundwater should be placed into perspective, because the Risk Assessment assumed that residential exposures would actually take place, whereas this will not likely occur, since WRF is to be transferred to the USFWS. Consequently, considering that the likely receptors at WRF in the future will be workers, visitors, and educators, the risks and hazard indices that were calculated for soil and groundwater are likely to be significant overestimates, due to the conservative assumptions that were used to calculate residential exposures. In addition, the risks associated with fish ingestion exposures also are likely to be overestimated, due to the conservative exposures assumptions that were used in the exposure calculations.

Risks associated with exposures to soils from the site-wide grouping, and with site-wide groundwater, sediment, and surface water were lower than or within the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  target risk range for health protection at Superfund sites. Hazard indices did not exceed one for any of the pathways associated with these media.

An evaluation was conducted for chemicals that were determined to be within background concentrations, but that exceeded their respective RBCs. Because risks for chemicals within background levels were often greater than risks associated with exposures to COPCs, eliminating these chemicals may have resulted in an underestimation of overall risks, if chemicals that were site-related and chemicals that were within background levels were evaluated together in the HHRA.

## 10.2 ECOLOGICAL RISK ASSESSMENT

The purpose of the ERA is to assess the potential for adverse effects to nonhuman receptors resulting from exposure to chemicals at WRF. The detailed ERAs can be found in the Draft Final FFSS for OU1 (USAEC, 1997a), OU2 and OU4 (USAEC, 1997b), and OU3 (USAEC, 1996a). These detailed risk assessments are presented in Appendix A of this RI report. The ERA was conducted in accordance with national and regional USEPA guidance for evaluating ecological risks at hazardous waste sites (USEPA, 1989a,b, 1992, and 1994a) and in accordance with relevant Army guidance (Wentsel et al. 1994). Consistent with this guidance, the approaches used in the ERA are similar to those used in the HHRA. The physical features of the site are first described and individual organisms, populations, or communities likely to occur at WRF are identified. The COPCs are then identified along with the pathways by which ecological receptors could be exposed to chemicals. The potential toxicity of the COPCs to ecological receptors selected for evaluation is then characterized. Finally, information on exposure and toxicity are combined to derive qualitative or quantitative estimates of the potential for adverse effects to ecological resources at WRF.

### 10.2.1 Soil Invertebrates

Organic and inorganic chemicals identified as COPCs were compared to available earthworm Toxicity Reference Values (TRVs). The available earthworm TRVs were exceeded by the maximum surface soil concentrations of chromium (Environmental Effects Quotient [EEQ] of 242), and to a lesser

extent, mercury (EEQ of 95), copper (EEQ of 8.0), zinc (EEQ of 1.9), and naphthalene (EEQ of 1.1). With the exception of sample location RISS55, chromium did not show a distributional pattern at WRF that would suggest these chemicals are associated with site-related activities. Instead, the level of contamination suggests the presence of this chemical at a relatively consistent concentration throughout the site. Based on historical site use information, which does not indicate activities that would lead to widespread chromium contamination at WRF, it is likely the detected concentrations of chromium are mostly reflective of naturally occurring levels and not the results of site-related activities. Mercury was detected at concentrations above background. Copper and zinc were detected at elevated concentrations at only a few sample locations.

### 10.2.2 Terrestrial Wildlife

Potential adverse effects to terrestrial wildlife from the ingestion of earthworms and surface soil were evaluated in the ERA. The results of the screening comparisons suggest a limited potential for adverse effects to terrestrial wildlife from the presence of chemicals in the terrestrial and aquatic food webs on WRF. Based on the magnitude of exceedance of the TRV for the selected indicator species, the greatest potential for adverse effects is to robins, and to a lesser extent, shrews from the ingestion of mercury in earthworms and surface soil. However, the risk estimate is driven to a large extent by the mercury concentration detected at a single sample location (20SS0101). The potential for receptor exposure to this localized area is likely to be limited, and the high concentration at this sample location may inappropriately bias the estimate of risk upwards. Furthermore, the high EEQs for robins and shrews resulted from the conservative assumption that all of the mercury detected in surface soil was in the form of methyl mercury. This is likely to overestimate the potential for adverse effects to the terrestrial receptors for several reasons. First, the bioconcentration factor (BCF) used to estimate the accumulation of mercury in earthworms from surface soil was based on a value reported for methyl mercury. Available information suggests that, when compared to inorganic mercury compounds, organic mercury is more readily absorbed by lipids, passes more easily through biological membranes, and is more slowly excreted by organisms (Clarkson and Marsh, 1982, Elhassani, 1983, Greener and Kochen, 1983). All of these factors lead to a greater accumulation of organic than inorganic mercury in earthworms. Therefore, if only a proportion of the mercury in surface soil is composed of organic mercury, the potential accumulation of mercury in earthworms and the subsequent dietary concentrations of mercury calculated for robins and shrews are likely to have been overestimated in the ERA. Second, inorganic mercury is always less toxic than the organic forms of mercury, and methyl mercury is the most toxic form of organic mercury (Eisler, 1987). The EEQs were calculated for both inorganic mercury and methyl mercury for robins and shrews to illustrate the difference in the potential toxic effects of mercury in each of its forms. The EEQ for shrews is reduced from 9.2 to less than one if it is assumed that mercury is present in its inorganic form. Meanwhile, the EEQ for robins is reduced from 78 to 4.4 based only on the use of a BCF for inorganic mercury. Although it is likely that only a proportion of the mercury detected in surface soil and likely to occur in earthworms would be in the inorganic form, the above example illustrates the potential overestimation of the risks to receptor species from the conservative assumption that mercury in soil is entirely in the methyl mercury form.

The results of the terrestrial food web models also indicate some potential for adverse effects to robins from the ingestion of DDT and its breakdown products (DDTr) in earthworms and surface soil, to heron from the ingestion of DDTr in fish and sediment from the Main Ditch Drainage and the Marumsco Creek/Occoquan Bay, and from the presence of methyl mercury in fish and sediment from the Main Ditch Drainage and the Pond, and to spotted sandpiper and raccoon from the presence of PCB-1260 in the Main Ditch. However, the EEQs for all of these chemical/receptor combinations were less than or equal to 5.0 indicating only a limited potential for adverse effects.

### 10.2.3 Summary of Sediment Results

PAHs were detected in sediment at the highest concentrations relative to the TRVs and have the greatest potential to adversely affect benthic organisms. PAHs were ubiquitous at WRF and were detected in the sediment throughout all sampled water bodies except the Pond. The greatest potential for adverse effects to benthic organisms from the presence of PAHs in sediment is likely to be in the Main Ditch and in Marumsco Creek/Occoquan Bay. The maximum detected concentrations of all detected PAHs exceeded the TRVs [EEQs ranging from 1.3 for chrysene to 196 for 2-methylnaphthalene

when compared to the Effects Range-Low (ER-L)] and the largest number of PAHs were detected in the Main Ditch. Meanwhile, the highest concentration of PAHs relative to the TRVs were detected in Marumsc Creek/Occoquan Bay (EEQ ranging from 0.5 for benzo(a)anthracene to 447 for acenaphthene when compared to the ER-L). Several of the PAHs were detected in both water bodies at concentrations exceeding the Effects Range-Medium (ER-M), suggesting the potential for adverse effects to most benthic organisms at some locations. PAHs were detected at generally lower concentrations relative to the TRVs in the Northeast Ditch (EEQs ranging from 1.1 for benzo(a)pyrene to 83 for acenaphthene when compared to the ER-L) and the Southern Drainage (EEQs ranging from 1.3 for phenanthrene to 96 for acenaphthene when compared to the ER-L). Only isolated chemicals were detected at concentrations exceeding the ER-Ms in the Northeast Ditch and Southern Drainage, suggesting a more limited potential for adverse effects in these water bodies.

No consistent spatial trend was apparent for the PAHs detected in the water bodies associated with WRF. The lack of a spatial trend in the water bodies, however, is not unusual given that PAHs are ubiquitous contaminants in the environment and are likely to have originated from a variety of different sources. Based on the drainage basins and the occurrence of PAHs throughout the water bodies on WRF, the majority of PAHs detected in the Main Ditch, the Northeast Drainage, and the Southern Drainage are likely to have originated from on-site locations. Meanwhile, Marumsc Creek and the Occoquan Bay, are components of a highly urbanized watershed, and are likely to receive PAHs from areas both within and outside the bounds of WRF. Although the origin of the chemical does not affect the potential for adverse effects, it may affect the evaluation of remedial alternatives and should be considered when evaluating remedial options.

The pesticide chlordane and its constituents, and to a lesser extent, DDT and its metabolites were detected in the Main Ditch and Marumsc Creek/Occoquan Bay at concentrations that could adversely affect benthic organisms. However, these pesticide compounds were detected at only a limited number of sample locations suggesting the potential for adverse effects at only isolated locations.

Chlordane and/or its constituents were detected at only three locations in the upper reaches of the Main Ditch (RISD27 through RISD29 [part of OU3]; EEQ of up to 526 when compared to the ER-L) and at two locations in the Marumsc Creek/Occoquan Bay grouping (RISD1 and RISD2; EEQ of up to 190 when compared to the ER-L). Chlordane compounds were consistently detected at concentrations above the ER-M, suggesting the potential for adverse effects to most benthic organisms at these isolated locations.

DDD was only detected at two locations in the Main Ditch (RISD27 and RISD35[OU3]; EEQ of up to 12 when compared to the ER-L), and at one location in the Marumsc Creek/Occoquan Bay (RISD19; EEQ of 8.5) immediately downgradient of AREE 1[OU1], while DDD and DDE were detected at only a single sample location in the Marumsc Creek/Occoquan Bay (RISD19). DDT and/or its metabolites were detected at concentrations below or only slightly exceeding the ER-M (EEQ of up to 2.6 for DDT in Marumsc Creek/Occoquan Bay), indicating a limited potential for adverse effects at locations where these chemicals were detected. The results of this analysis suggests that pesticide compounds could be adversely affecting benthic organisms, but that adverse effects resulting from pesticides, would be localized. PCB-1260 was detected in the Main Drainage Ditch and Marumsc Creek/Occoquan Bay. The detected PCB concentration in the Main Ditch and, to a lesser extent, Marumsc Creek/Occoquan Bay exceeded sediment toxicity values derived by OMEE (1993) and Smith et al. (1996) indicating the potential for adverse effects to benthic organisms. It should be noted, however, the detected concentration did not exceed the higher sediment toxicity values derived according to Hull and Suter (1994).

Several inorganic COPCs were detected at concentrations exceeding their TRVs in the sediments of all water bodies except the Pond. However, the magnitude of TRV exceedances (EEQs ranging from 1.1 for copper and nickel in the Southern Drainage to 3.5 for silver in the Marumsc Creek/Occoquan Bay grouping when compared to the ER-L) suggests only a very limited potential for adverse effects to benthic organisms. Furthermore, with few exceptions (silver in the Marumsc Creek/Occoquan Bay grouping; zinc in the Northeast Ditch; and iron in the Southern Drainage), the concentrations of the inorganic COPCs detected on-site did not exceed those detected at reference sample locations.

#### 10.2.4 Summary of the Surface Water Chemical Analysis

No organic chemicals are likely to adversely affect aquatic life in the water bodies of WRF. The above comparison, however, suggests there is the potential for adverse effects to aquatic life from the presence of several inorganic chemicals in the surface water of WRF. The mean concentrations of one or more inorganic chemicals were detected at concentrations exceeding the chronic ambient water quality criteria (AWQC) in each of the sampled water bodies, while mean aluminum concentrations exceeded the acute AWQC. Among the inorganic chemicals, aluminum consistently exceeded both the chronic and acute AWQC to the greatest extent. However, available information suggests that many of the chemicals detected in surface water are unlikely to be originating from on-site locations. WRF receives discharge from an area immediately to the north of the facility boundary. At the time the samples were collected, the area immediately north of the facility boundary was in the process of being cleared for a golf course and housing development. Furthermore, precipitation events occurred for several days prior to and during the collection of surface water samples and field notes indicate a relatively high silt content in the surface water bodies in general and, in particular, in the surface water samples collected from close to the northern facility boundary. It is likely the ongoing precipitation combined with the ongoing clearing activities resulted in the elevated concentrations of inorganics detected in surface water at WRF and that previous on-site activities were not the primary source of these chemicals. This observation is further confirmed by the observation of higher aluminum concentrations in surface water samples taken from water bodies receiving direct runoff from the cleared area just north of the facility boundary than in the water bodies less influenced by runoff from this area. For example, the average aluminum concentration in the Northeast Ditch, which receives discharge directly from the cleared area and in which a high silt content was observed, was approximately one order of magnitude greater than the average aluminum concentration in the Marumsco Creek/Occoquan Bay surface water.

**Appendix A**

**Human Health Risk Assessment for Operable Unit Three**

### 3.0 HUMAN HEALTH RISK ASSESSMENT

#### 3.1 PURPOSE AND APPROACH

This section of the FFS presents the HHRA which evaluates the probability and magnitude of adverse effects on human health associated with actual or potential exposure to site-related chemicals at OU3 of WRF. OU3 consists of the Main Drainage Ditch that runs from the northern property boundary to the point where it discharges into the Belmont and Occoquan bays, as well as the area that is located between the Main Drainage Ditch and the north side of the Main Compound where PCB-contaminated soils were removed in 1995. The location of OU3 is presented in Figure 2-20. The northern branch of the Main Drainage Ditch receives discharge from an area north of the facility boundary as well as runoff from on-site areas. The northwestern branch originates close to the main entrance of WRF and receives runoff predominantly from on-site locations. The two branches converge approximately 1,000 feet east of the western facility boundary. Following the convergence of the north and northwestern branches, the Main Drainage Ditch flows approximately 1,500 feet adjacent to the Main Compound area, where it receives discharge from a ditch that drains the Main Compound area. The Main Drainage Ditch travels roughly 1,000 feet further to the east and turns abruptly to the south, where it crosses under Charlie Road. The Main Drainage Ditch continues to the south, ultimately discharging to the Occoquan/Belmont Bay.

This focused HHRA is based on analyzed data collected by ICF KE and Earth Tech. This HHRA is consistent with Section 300.430(d)(4) of the NCP, which directs that a Baseline HHRA be conducted to characterize the current and potential threats to human health and the environment that may be posed by contaminants migrating to groundwater or surface water, releasing to air, leaching through soil, remaining in the soil, and bioaccumulating in the food chain. This section of the NCP was applied to the WRF OU3 HHRA, in which human health effects associated with site-related chemicals in specific media (surface water, sediment, fish, groundwater, surface soil, and subsurface soil) were evaluated. This HHRA also is consistent with guidance and standards developed by the USEPA (USEPA, 1986a,b, 1989a,b, 1991a, 1992c,d,e) and USEPA Region III. In addition, the methodologies for conducting the HHRA have been discussed with USEPA Region III and the VADEQ in correspondence and a meeting.

The remainder of this HHRA is organized as follows:

- **Identification of Chemicals of Potential Concern (COPCs) (Section 3.2).** The chemicals detected in sediment, surface water, fish, groundwater, surface soil, and subsurface soil are identified and discussed. The analytical data are summarized by presenting the frequency of detection and the range of detected concentrations in site and background samples. COPCs are selected for quantitative evaluation in the human health risk evaluation based on an evaluation of the data, a comparison of maximum site concentrations to USEPA Region III RBCs, and a comparison of site and background concentrations for inorganic chemicals.
- **Human Exposure Assessment (Section 3.3).** The potential pathways through which individuals may be exposed to COPCs in sediment, surface water, fish, groundwater, surface soil, and subsurface soil are discussed and exposure pathways are selected for evaluation. The chemical concentrations at the points of potential exposure are presented for each pathway selected for quantitative evaluation. Assumptions are made for the magnitude, frequency, and duration of exposure for each pathway and potential exposures (intakes) are then quantified.
- **Toxicity Assessment (Section 3.4).** The potential toxicity of chemicals to humans and the chemical-specific health effects criteria to be used in the quantitative assessment are presented.
- **Risk Characterization (Section 3.5).** Quantitative risk estimates are developed for each exposure pathway selected for evaluation by combining the toxicity criteria with estimated intakes of potentially exposed individuals.
- **Uncertainties (Section 3.6).** Major sources of uncertainty in the HHRA are discussed.

- **Summary and Conclusions (Section 3.7).** The HHRA is summarized and the conclusions are presented.

### 3.2 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

This section of the HHRA discusses the methodology used to summarize the data (Section 3.2.1) and the methodology used to select COPCs for detailed evaluation in the HHRA (Section 3.2.2). The summarization of data and the selection of COPCs are then presented for each medium in Sections 3.2.3 through 3.2.8. Finally, a summary of the COPCs selected in all media is provided in Section 3.2.9.

#### 3.2.1 Methodology for Data Summary

The first step in the HHRA process was to summarize the analytical data collected during the RI.<sup>1</sup> The following steps, which are in accordance with USEPA (1989a) guidance, were used to summarize the analytical data for this HHRA:

- Analytical data were summarized by environmental medium (i.e., sediment, surface water, fish, groundwater, surface soil, and subsurface soil). The data summary for each environmental medium is described later in this section.
- Analytical data for all media except fish were compared to blank (laboratory, field, and trip) concentration data. If the detected concentration in a site-related sample was less than 10 times (for common laboratory contaminants) or five times (for all other compounds) the concentration in the corresponding blank sample, the sample was qualified with a B (i.e., the analyte was found in the method or QC blank as well as the sample). In accordance with USEPA Region III, B-qualified data were rejected and were not used to determine the arithmetic mean of detected concentrations. Data that were rejected (R-qualified) by the laboratory were not used in the HHRA. Data that were considered estimated values (e.g., J-qualified) were used in the HHRA without modification.
- Data from duplicate samples (samples collected from the same sample location at the same time) were averaged together and treated as one result. If a chemical was detected in only one of two duplicate samples, the detected value was averaged with one-half the quantitation limit of the nondetect sample, and the result was counted as one detect sample.
- Mean chemical concentrations for a given medium were calculated by averaging the detected concentrations with one-half the sample quantitation limit of the nondetects. One-half the sample quantitation limit is typically used in HHRA (USEPA, 1989a) when averaging non-detect concentrations because the actual value can be between zero and a value just below the sample quantitation limit. This procedure also was used when the non-detect sample quantitation limit was two or more times higher than the maximum detected concentration in that medium. The uncertainties associated with using one-half the sample quantitation limit for non-detects will be discussed in the Uncertainty Section of the report.
- Frequency of detection was calculated as the number of samples in which the chemical was detected over the total number of samples collected for the particular grouping.

#### 3.2.2 Selection of Chemicals of Potential Concern

Once the sampling data from OU3 were grouped and summarized, COPCs were selected. The purpose of selecting COPCs is to identify those chemicals that are present as a result of past activities at the site and most likely to be of concern to human health. Therefore, a screening process was used in the HHRA to eliminate: 1) chemicals present at concentrations below levels of concern (as represented by an RBC screening); 2) chemicals present at or below naturally occurring background levels; or 3) essential human nutrients that were present at concentrations below levels of concern. The following methodology was used to conduct these screenings.

<sup>1</sup> It should be noted that additional validation to the data is planned, and will be conducted by an independent contractor at a later date.



- The maximum detected concentrations of organic and inorganic compounds were compared to USEPA Region III RBCs, in accordance with Region III guidance (USEPA, 1995a). The RBCs are health-protective chemical concentrations that are back-calculated using toxicity criteria, a  $1 \times 10^{-6}$  target risk level or a 0.1 hazard index, and conservative exposure parameters. A hazard index of 0.1, instead of 1.0, was used to ensure that compounds that could combine to result in a hazard index greater than 1 were not eliminated from evaluation. If the maximum detected on-site chemical concentration was less than the relevant RBC, the probability of contracting cancer would be less than 1 in 1 million and adverse non-carcinogenic effects would not be expected to occur. As a result, these chemicals were eliminated from further evaluation.

Residential soil RBCs were used to screen surface soil and sediment concentrations, since residential exposures were evaluated in the HHRA. Subsurface soil concentrations were screened using industrial soil RBCs, since the most likely receptors to subsurface soil would be excavation workers (see Exposure Assessment). Tap water RBCs were used to screen groundwater concentrations; in addition, because RBCs are not available for surface water, tap water RBCs were conservatively used for comparison to surface water chemical concentrations, even though the surface water from OU3 is not used for drinking water purposes. Finally, fish concentrations were compared to fish tissue RBCs. RBCs for all chemicals detected at OU3 are presented in Table 3-1.

RBCs are not available for four essential human nutrients, i.e., calcium, magnesium, sodium, and potassium. These chemicals were eliminated as COPCs if they were present at concentrations that would not be likely to cause adverse effects, i.e., below allowable daily intakes (ADIs).

RBCs are not available for lead, since no toxicity criteria exist for this chemical. Therefore, other available lead screening criteria were used instead of RBCs for the purposes of screening lead in the HHRA. For sediment and soil, the residential soil screening level of 400 mg/kg (USEPA, 1994b) was used, while for surface water and groundwater, the lead action level of 15  $\mu\text{g/L}$  was used.

- In accordance with USEPA (1989a), inorganic chemicals present at naturally occurring levels may be eliminated from quantitative HHRA. Therefore, an additional screening was conducted for inorganic compounds that were elevated above RBC levels. In order to determine if detected levels of inorganic compounds present at concentrations exceeding RBCs were representative of naturally occurring background levels, on-site data were statistically compared to site-specific background data for each medium.

The site and background data were first tested using the Shapiro-Wilks test to determine the distribution type of the data sets. For normally or log-normally distributed data, a two-tailed variance ratio test (the F test) was performed to determine if the variances of the on-site and background data sets were similar. If the variances for the two data sets were found to be similar, then the one-tailed pooled variance t-test was considered appropriate to test for similarity between on-site and background levels. If on-site and background variances were found to differ significantly, or if the data were determined to be neither normally nor log-normally distributed, then a nonparametric test (the one-tailed Mann-Whitney test) was used to test for similarity between on-site and background levels. All statistical tests were performed using a significance level of 95% ( $\alpha = 0.05$ ) and are described in detail by Zar (1984). Statistical tests for log-normally distributed data were performed using natural log-transformed monitoring data. Those inorganic compounds that were considered to be statistically within background levels were eliminated from further consideration.

In accordance with USEPA Region III policy, inorganic compounds that were present at concentrations within background levels, but greater than their RBCs, were evaluated separately from risks associated with COPCs that both exceeded background and RBCs. Risks for these chemicals are discussed in the Uncertainty Section.

- Some analytes collected during the sampling events were not presented or evaluated in the HHRA, including TPH (for which no toxicity criteria are available) and some water and sediment quality parameters (i.e., moisture for sediment samples; hardness and suspended sediment for surface water samples). Section 2 of the FFS should be referred to for samples in which these analytes were analyzed for, and for a summary of these data.

The following sections discuss and summarize the sediment, surface water, fish tissue, groundwater, surface soil, and subsurface soil data that were used in the HHRA, and present the selection of COPCs in each grouping.

### 3.2.3 Sediment

Sediment samples from OU3 were collected from the portion of the Main Drainage Ditch adjacent to the Main Compound Area, as well as from two ditches in the north/northwestern portion of the site that drain into the Main Drainage Ditch adjacent to the Main Compound. A review of the sediment data indicated that the sediment samples collected in the Main Drainage Ditch, directly north of the Main Compound (i.e., RISD31 through RISD35) had elevated levels of PCBs. Historical information indicates that PCBs from the former oil/water separator and the former washrack at the Main Compound had been released and transported to the Main Drainage Ditch. Consequently data from these samples were grouped together for the purposes of the HHRA and the area was designated as the PCBs Area. The sediment samples collected to the north and northwest of the Main Compound (RISD26 through RISD30) were upgradient and unaffected by the PCB contamination, but were instead affected by pesticides contamination that were likely due to past pesticide applications along the perimeter and/or upgradient of the WRF. These samples were grouped separately, and were designated as the Pesticides Area. Evaluating these two groups will allow a separate assessment of the PCBs Area and the portion of the drainage ditches where pesticides were detected. Evaluating two groupings instead of one large grouping will ensure that PCB and pesticide reasonable maximum exposure (RME) concentrations are not diluted over the entire drainage ditch area.

As discussed in Section 2.0 of the FFS, five background sediment/surface water samples were collected from Mason Neck Wildlife Refuge, which is located away from potential source areas and unaffected by past activities at WRF. The range of concentrations for chemicals detected in background sediment samples is presented in the data summary table for both sediment groupings to show how the site concentrations compare to the background levels. The background inorganics data were statistically compared to site concentrations to determine which inorganics could be considered within background levels. Even though organics were detected in background samples, no organics were eliminated from evaluation based on their presence in background samples (USEPA, 1989a).

The following sections summarize the sediment data collected from the PCBs and Pesticides Area groupings. The data summaries provide the frequency of detection, the arithmetic mean, the range of chemical-specific detection limits, the range of detected concentrations, the residential soil RBCs, and the range of background concentrations for all chemicals detected in sediment. Chemicals that were retained for quantitative evaluation based on the comparison of site concentrations to RBCs and to background concentrations were marked with an asterisk (\*) in the data summary table.

#### 3.2.3.1 PCBs Area

Sediment samples from the PCBs Area included RISD31 through RISD35. Samples RISD31 through RISD34 were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, polynuclear aromatic hydrocarbons (PAHs), and PCTs; sample RISD35 was analyzed for all the same analytes, except PCTs. The data summary for chemicals detected in the PCBs Area is presented in Table 3-2.

As shown in Table 3-2, 19 organics were detected in the PCBs Area, 16 of which were PAHs. All organic chemicals, except for benzo(a)pyrene and PCB-1260, had maximum detected concentrations that were below their respective USEPA Region III residential soil RBCs, and thus were eliminated from evaluation in the HHRA. Benzo(a)pyrene and PCB-1260 were the only organic chemicals that were selected for quantitative evaluation from the PCBs Area.

Fifteen inorganic chemicals were detected in sediment from the PCBs Area and are summarized in Table 3-2. A comparison of maximum detected concentrations to Region III residential soil RBCs (or

to allowable daily intake levels for essential human nutrients and the USEPA residential screening level for lead) indicated that the only inorganics that exceeded respective screening levels were aluminum, beryllium, iron, manganese, and vanadium. The remaining inorganic chemicals were, therefore, eliminated from further evaluation in the HHRA.

The next step of the selection process for chemicals detected in the PCBs Area sediment was to conduct a comparison of PCBs Area sediment concentrations to site-specific background concentrations for those inorganic chemicals that exceeded residential soil RBCs. The statistical comparison indicated that all five inorganic chemicals that exceeded RBCs were within background levels.

Based on the screening of all chemicals detected in the PCBs Area sediment to residential soil RBCs and of inorganic chemicals to background levels, the only site-related chemicals selected for quantitative evaluation in the HHRA were benzo(a)pyrene and PCB-1260. As requested by USEPA Region III, any inorganic chemicals that exceeded RBCs but were within background levels were evaluated separately from site-related chemicals. Accordingly, exposures and risks associated with aluminum, beryllium, iron, manganese, and vanadium were evaluated separately from site-related chemicals.

### 3.2.3.2 Pesticides Area

Sediment samples from the Pesticides Area included RISD26 through RISD30, and all samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PAHs. As shown in Figure 2-28, two of the sediment samples (RISD26 and RISD29) were collected in the northwestern ditch, two of the sediment samples (RISD27 and RISD28) were collected in the northern ditch, and one sediment sample (RISD30) was collected upgradient of the PCBs Area, but downgradient of the convergence of the two upgradient ditches. The data summary for chemicals detected in the Pesticides Area is presented in Table 3-2.

As shown in Table 3-2, 16 organics were detected in sediment from the Pesticides Area, including 12 PAHs, three pesticides, and one semivolatile. A comparison of maximum detected organic chemical concentrations to USEPA Region III residential soil RBCs indicated that only benzo(a)pyrene was detected above its respective RBC. Therefore, benzo(a)pyrene was the only organic chemical from the Pesticides Area that was selected for quantitative evaluation in the HHRA.

Also shown in Table 3-2, 16 inorganic chemicals were detected in sediment from the Pesticides Area. A comparison of maximum detected concentrations to USEPA Region III residential soil RBCs (or to allowable daily intake levels for essential human nutrients and the residential screening level for lead) indicated that the same inorganics that exceeded respective screening levels for the PCBs Area (i.e., aluminum, beryllium, iron, manganese, and vanadium) exceeded screening levels in the Pesticides Area. The remaining inorganic chemicals were therefore eliminated from further evaluation in the HHRA.

The next step of the selection process was to compare sediment concentrations to site-specific background concentrations for those inorganic chemicals that exceeded residential soil RBCs. The statistical comparison indicated that, once again, all five inorganic chemicals that exceeded RBCs were within background levels.

Based on the screening of all chemicals detected in the Pesticides Area sediment, the only site-related chemical selected for quantitative evaluation in the HHRA was benzo(a)pyrene. As requested by USEPA Region III, inorganic chemicals that exceeded RBCs but were within background levels were evaluated separately from site-related chemicals. Therefore, exposures and risks associated with aluminum, beryllium, iron, manganese, and vanadium were evaluated separately from site-related chemicals.

### 3.2.4 Surface Water

Surface water samples from OU3 were collected at the same locations as the sediment samples for the PCBs and Pesticides Areas. Surface water data were grouped into samples collected from each of these two areas, identical to the two sediment groupings. Only unfiltered (i.e., total) inorganics surface water concentrations were collected from site and background locations. It should be noted that north

and upgradient of OU3 at WRF is an area where development for a new golf course and residential housing is occurring, and that the surface water samples from both the Pesticides and PCBs Area were collected during or soon after a storm event. It is, therefore, possible that runoff from the construction site could have caused the surface water samples from the PCBs and Pesticides Areas to have elevated levels of suspended sediment. Uncertainties associated with elevated inorganics surface water concentrations due to upgradient construction activities will be discussed in the Uncertainty Section.

As discussed in Section 2.0 of the FFS, five background surface water samples were collected from the same locations as the sediment samples, away from potential source areas and unaffected by activities at WRF. The range of concentrations for chemicals detected in background surface water is presented in the data summary table for both surface water groupings to show how the site concentrations compare to the background levels. Background inorganics data were statistically compared to site concentrations to determine which inorganics could be considered within background levels.

The following sections summarize the surface water data that were collected at OU3. Table 3-3 is a summary table that presents the frequency of detection, the arithmetic mean, the range of chemical-specific detection limits, the range of detected concentrations, USEPA Region III tap water RBCs, and the range of background concentrations for all chemicals detected in surface water. Chemicals that were retained for quantitative evaluation based on the RBC comparison and the comparison of site and background concentrations were marked with an asterisk (\*) in the data summary table.

#### **3.2.4.1 PCBs Area**

Five surface water samples were collected from the PCBs Area at the same locations as the sediment samples (i.e., RISW31 through RISW35). Samples RISW31 through RISW34 were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs, while RISW35 was analyzed for all these compounds, except for PCTs. The data summary for chemicals detected in PCBs Area surface water is presented in Table 3-3.

As shown in Table 3-3, 15 inorganics were detected in the PCBs Area; no organics were detected. A comparison of maximum detected concentrations to USEPA Region III tap water RBCs (or to allowable daily intake levels for essential human nutrients and the USEPA action level for lead) indicated that the only inorganics that exceeded respective screening levels were aluminum, iron, and manganese. The remaining inorganic chemicals were therefore eliminated from further evaluation in the HHRA.

The next step of the selection process was to conduct a comparison of PCBs Area surface water concentrations to site-specific background concentrations for those inorganic chemicals that exceeded tap water RBCs. The statistical comparison indicated that only manganese was within background levels.

Based on the screening of all chemicals detected in the PCBs Area surface water to tap water RBCs and to background levels, the only site-related chemicals selected for quantitative evaluation in the HHRA were aluminum and iron. As requested by USEPA Region III, any inorganic chemicals that exceeded RBCs but were within background levels were evaluated separately from site-related chemicals. Therefore, exposures and risks associated with manganese were evaluated, although separately from site-related chemicals.

#### **3.2.4.2 Pesticides Area**

Five surface water samples from the Pesticides Area were collected from the same locations as the Pesticides Area sediment samples. Surface water samples from the Pesticides Area (i.e., RISW26 through RISW30) were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, PAHs, and TAL metals. The data summary for chemicals detected in the Pesticides Area is presented in Table 3-3.

As shown in Table 3-3, one organic and 15 inorganics were detected in the Pesticides Area. A comparison of maximum detected concentrations to USEPA Region III tap water RBCs (or to allowable daily intake levels for essential human nutrients and the USEPA action level for lead) indicated that the only chemicals that exceeded respective screening levels were aluminum, iron, manganese, and vanadium. The remaining chemicals were therefore eliminated from further evaluation in the HHRA.

The next step of the selection process was to conduct a comparison of Pesticides Area surface water concentrations to site-specific background concentrations for those inorganic chemicals that exceeded tap water RBCs. The statistical comparison indicated that all four inorganics that exceeded tap water RBCs were greater than background levels.

Based on the screening process, the site-related chemicals selected for quantitative evaluation in the HHRA were aluminum, iron, manganese, and vanadium.

### 3.2.5 Fish

Fish fillet data from samples collected from the Main Drainage Ditch were evaluated in the HHRA. Fish samples were collected in the Main Drainage Ditch, north of the Main Compound, down to about 1,000 feet south of Charlie Road, where a beaver dam is located. At the time samples were collected, it appeared that the beaver dam could prevent most fish species from moving across the barrier. However, it is not known how often the dam may be breached to allow fish into and out of the Main Drainage Ditch. The fish fillet samples included samples BASS1F-5F (Ditch), CARP1F-3F (Ditch), CRAPPIE1F-5F (Ditch), EEL1F-5F (Ditch), SFISH2F<sup>2</sup>-5F (Ditch), and WPERCH 1F-5F (Ditch). It should be noted that although it is likely that most of the fish samples were collected above the beaver dam, there is no documentation that specifies the exact location where each of the fish samples was collected. Therefore, it is possible that some of the fish tissue samples were collected below the beaver dam. The fish tissue from the six species of fish were analyzed for lead, mercury, pesticides/PCBs, and PCTs. Only fillet tissue samples were used in the HHRA, because it was assumed that individuals would consume the fillet portion of the fish, rather than the whole body of the fish.

Similar to the evaluations for surface water and sediment, the following text summarizes the fish tissue samples that were collected, and a summary table (Table 3-4) is presented that provides the frequency of detection, the arithmetic mean, the range of chemical-specific detection limits, the range of detected concentrations, and the fish RBCs for all chemicals detected in fish. Concentrations for the organic chemicals detected in USEPA Region III fish tissue that are presented in Table 3-4 were not normalized to percent lipids for the HHRA because only non-normalized data are appropriate for determination of exposure estimations and risk. Chemicals that were retained for quantitative evaluation based on the RBC comparison were marked with an asterisk (\*) in the data summary table.

As shown in Table 3-4, fillet tissue data from six species were collected, and the only chemicals that were detected in each of the fish species were PCB-1260 and DDE. Other chemicals that were detected in at least one species included delta-BHC, chlordane, DDD, mercury, and methoxychlor. A comparison of maximum fish tissue concentrations to fish tissue RBCs indicated that all chemicals for all species, except for alpha-chlordane in carp and methoxychlor and DDE in white perch, were above RBC levels, therefore, these chemicals were retained for evaluation in the HHRA.

It should be noted that pesticide concentrations have been detected in fish collected from regional background locations typically at levels similar to or higher than concentrations detected in fish from OU3 (see Section 4.0 of the FFS for more discussion on regional fish tissue concentrations). In addition, some of the pesticides detected in fish (e.g., chlordane, DDE, delta-BHC, methoxychlor) were not detected in sediment from the PCBs Area (where the fish were collected). DDE, delta-BHC, and methoxychlor also were not detected in sediment from the Pesticides Area. This suggests that the pesticide and PCB concentrations detected in fish may not be completely associated with site-related contamination.

Even though fish tissue data were available for OU3 to determine risks associated with ingestion of fish, in accordance with USEPA Region III, surface water concentrations were compared to Water and Organism Ambient Water Quality Criteria (AWQC). The purpose of the comparison was to determine the potential for risks associated with human exposures due to ingestion of water and organisms from OU3 ditches. As shown on Table 3-5, the only chemicals whose maximum surface water concentrations exceeded the Water and Organism AWQCs were iron and manganese in both the PCBs Area and the Pesticides Area. This indicates that risks associated with exposures to iron and manganese could

<sup>2</sup> Note that sample SFISH1F (Ditch) was lost during shipment, thus no results for this sample were available.

potentially occur to individuals if they were to actually consume surface water and fish from the Main Drainage Ditch Area at OU3 (which, as discussed later in the Exposure Assessment, is an unlikely scenario). However, it should be noted that at the time that surface water samples were collected, the area immediately north of WRF was being cleared for a golf course and a housing development, contributing to a relatively high silt content in the surface water samples. The elevated suspended solids concentrations may have contributed to the exceedances of Water and Organism AWQCs for iron and manganese. In summary, it is difficult to draw any definitive conclusions from the comparison of surface water concentrations in the PCBs and Pesticides Areas to the Water and Organisms AWQC values.

### 3.2.6 Groundwater

Groundwater samples were collected in the surficial aquifer, downgradient of the Main Compound, to determine the extent of contamination associated with past activities in this area. The samples collected in this area were grouped into the PCBs Area Grouping and included samples MW-39, 55, 56, 57, 58, 62, 84, 85. Two rounds of samples were collected from each well, except MW-39, from which only one round of samples was collected. All groundwater samples used in the HHRA were unfiltered samples and were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and PCTs.

As discussed in Section 2.0 of the OU2 and OU4 FFS, four background wells were installed at WRF, from which two rounds of groundwater samples were collected: MW-52, on the northwest side of WRF; MW-53, on the northern boundary of WRF; and MW-54, on the south side of Bayview Road. In addition, three rounds of groundwater samples were collected from background sample MW-63, on the northern boundary of WRF. Samples collected from these wells were unaffected by past activities at WRF. The range of concentrations for chemicals detected in background groundwater samples is presented in Table 3-6 to show how the site concentrations compare to the background levels. The background inorganics data were statistically compared to site concentrations to determine whether any of the inorganics detected in groundwater were within background levels. All background samples, except one round of data from MW-63 were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, PAHs, and PCTs. The single round from MW-63 was analyzed for VOCs, SVOCs, and pesticides/PCBs.

The data summary for chemicals detected in the PCBs Area groundwater is presented in Table 3-6. As shown in Table 3-6, seven organics, primarily PAHs and pesticides, were detected in this groundwater grouping. A comparison of maximum detected concentrations to tap water RBCs indicated that only dieldrin was present at concentrations exceeding respective tap water RBCs.

Fourteen inorganic chemicals were detected in PCBs Area groundwater samples. A comparison of maximum detected inorganic concentrations to respective screening criteria indicated that the inorganics that exceeded the criteria were arsenic, iron, and manganese. The next step of the selection process for inorganics was to conduct a statistical comparison of groundwater concentrations to site-specific background concentrations for those inorganic chemicals that exceeded tap water RBCs. The statistical comparison indicated that iron and manganese were detected above background levels, thus were selected as COPCs.

### 3.2.7 Surface Soil

Surface soil samples were collected from AREEs 11 and 17, because of known PCB contamination in this area of the Main Compound. For the purposes of the HHRA, surface soil samples collected from this area were grouped into the "PCBs Area" grouping.

A total of 11 surface soil samples was collected from the PCBs Area to determine the extent of surface soil contamination associated with past activities in this area. Three of the samples were 0-6 inches surface soil samples collected by ICF KE, three were 0-6 inches surface soil samples collected by Earth Tech, while five were 0-2 feet surface soil samples collected from borings by ICF KE. All surficial soil samples from 0-6 inches and from 0-2 feet were grouped together in the risk assessment. All samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, and TAL metals. In addition, PCTs were analyzed for in the ICF KE data (in some cases, PCTs were only analyzed for when PCBs were detected). In addition, PAHs were analyzed for in 0-6 inches surface soil samples.

As discussed in Section 2.0 of the OU2 and OU4 FFS, five background surface soil samples (RISSBK-1, 2, 3, 4, and 5, all collected between 0-6 inches) were collected from locations along the northern and eastern boundary of WRF. In addition, three background 0-2 feet surface soil samples were collected from borings drilled on the northwest side of WRF (MW-52), on the northern boundary of WRF (MW-53), and on the south side of Bayview Road (MW-54). All background surface soil samples were collected from areas that were unaffected by past activities at WRF. The range of concentrations for chemicals detected in background surface soil samples is presented in Table 3-7 to show how the site concentrations compare to the background levels. The background inorganics data were statistically compared to site concentrations to see which inorganic chemicals detected in OU2 and OU4 were within background levels. All background samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs; in addition, surface soil samples collected from 0-6 inches also were analyzed for PAHs.

The data summary for chemicals detected in surface soil at the PCBs Area is presented in Table 3-7. As shown in Table 3-7, 22 organics were detected in surface soil samples, consisting primarily of PAHs. A comparison of maximum detected concentrations to residential soil RBCs indicated that benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, and PCB-1260 were detected above respective screening concentrations and were thus selected as COPCs in surface soil.

Eighteen inorganic chemicals were detected in surface soil from the PCBs Area. A comparison of maximum detected inorganic concentrations to respective screening criteria indicated that aluminum, arsenic, beryllium, iron, and manganese were above respective screening levels. The next step of the selection process was to conduct a statistical comparison of surface soil concentrations to site-specific background concentrations for those inorganic chemicals that exceeded residential soil RBCs. The statistical comparison indicated that all of the inorganics detected in the PCBs Area surface soil grouping were present at concentrations within background levels, thus none was selected as a COPC.

### 3.2.8 Subsurface Soil

Ten subsurface soil samples were collected from the PCBs Area. Subsurface soil samples were collected only by ICF KE, and consisted of all soil samples that were collected at depths below two feet. Samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs (in some cases, PCTs were analyzed for only where PCBs had been detected).

As discussed in Section 2.0 of the OU2 and OU4 FFS, six background subsurface soil samples from three borings, each at two depths, were collected from borings drilled on the northwest side of WRF (MW-52), on the northern boundary of WRF (MW-53), and on the south side of Bayview Road (MW-54). All background subsurface soil samples were collected from areas that were unaffected by past activities at WRF. The range of concentrations for chemicals detected in background subsurface soil samples is presented in Table 3-8 to show how the site concentrations compare to the background levels. The background inorganics data were statistically compared to site concentrations to see which inorganic chemicals detected in OU2 and OU4 were within background levels. All background samples were analyzed for TCL VOCs, SVOCs, pesticides/PCBs, TAL metals, and PCTs.

The data summary for chemicals detected in subsurface soil at the PCBs Area also is presented in Table 3-8. As shown in Table 3-8, PCB-1260 was the only organic chemical detected in subsurface soil. A comparison of the maximum detected concentration of PCB-1260 to its industrial soil RBC indicated that it was present below its screening level, and was thus not selected for evaluation in the HHRA.

Seventeen inorganic chemicals were detected in subsurface soil from the PCBs Area. A comparison of maximum detected inorganic concentrations to respective screening criteria indicated that none of the detected inorganics was present above respective screening levels, thus no inorganics from the PCBs Area were selected as COPCs.

It should be noted that confirmatory subsurface soil data were collected by IT for the Army Research Laboratory after PCB contamination excavations in the summer of 1995. However, due to the screening-level nature of these data (i.e., field-level data), they were not used in the HHRA.

### 3.2.9 Summary of Chemicals of Potential Concern

Table 3-9 summarizes the COPCs in all media sampled at OU3. As shown in this table, very few COPCs were identified in sediment (PCB-1260 and benzo[a]pyrene) and surface water (four inorganics), while five organics and one inorganic in fish were selected as COPCs. Dieldrin was the only organic selected as a COPC in groundwater, along with two inorganics. Finally, five PAHs and PCB-1260 were the only compounds selected as COPCs in surface soil. The only compounds that were selected as COPCs in more than one medium include PCB-1260, benzo(a)pyrene, iron, and manganese.

## 3.3 EXPOSURE ASSESSMENT

In this section, the potential pathways through which individuals may be exposed to COPCs in sediment, surface water, fish, groundwater, and surface soil from OU3 are identified and exposures are quantified (as noted above, no COPCs were selected for subsurface soil). A definition of an exposure pathway (Section 3.3.1) is followed by a discussion of potential exposure pathways through which populations could currently be exposed to COPCs at OU3 (Section 3.3.2). This is followed by a discussion on potential pathways of exposure under future land-use conditions (Section 3.3.3). For each pathway selected for quantitative evaluation, the COPCs concentrations at the points of exposure are estimated, followed by the methodology for calculating potential chemical intakes (Section 3.3.4).

### 3.3.1 Potential Exposure Pathways

An exposure pathway describes the course a chemical takes from the source to the exposed individual. It is defined by four elements:

- a source and mechanism of chemical release to the environment;
- an environmental transport medium (e.g., sediment) for the released chemical;
- a point of potential contact with the contaminated medium (referred to as the exposure point); and
- an exposure route (e.g., ingestion) at the contact point.

An exposure pathway is considered complete only if all four elements are present, and only complete exposure pathways will be quantitatively evaluated.

When conducting an exposure assessment, USEPA (1989a, 1991a) guidance requires that plausible exposures under both current and future land-use scenarios be evaluated in an HHRA. Accordingly, human exposure pathways are identified for current and potential future land-use conditions at OU3. The current land-use scenario assumes conditions as they currently exist, while the future land-use scenario evaluates potential risks that may be associated with possible changes in site use, assuming no remedial action occurs. In the following sections, information presented previously about COPCs at OU3 is combined with information on population locations, activity patterns, and land use to identify potential human exposure pathways under current and hypothetical future land-use conditions.

### 3.3.2 Current Land-Use Conditions

The potential exposure pathways through which humans could currently be exposed to contamination resulting from past activities at OU3 are discussed below for each exposure medium. In order to place this discussion into perspective, a description of OU3 is first presented, which provides some background for the exposure pathway analysis.

In general, the area surrounding WRF is residential. Northwest of the facility are former Army family housing units, which are currently used as residential housing; directly to the north, there is a proposed civilian residential development and a golf course. The Occoquan and Belmont Bays are located south and west, respectively, and are popular for recreation.

As described earlier, the areas of evaluation at OU3 consisted of the PCBs Area at the Main Compound and the Pesticides Area, in the north/northwestern portion of the facility. No specific activities occurred in the past for the Pesticides Area, which would have contributed to the contamination detected in this area. Past disposal activities associated with the former washrack and former oil/water separator most likely caused the contamination associated with the PCBs Area. The upper reaches of the



northwestern ditch contains water during runoff periods, while the northern ditch typically contains water. Vegetation along the ditches in the northern portion of OU3 is mostly grassy, with some shrubs. After the ditches converge and as the Main Drainage Ditch passes the Main Compound, and further to the Bay, the ditches contain 1-2 feet of water. The vegetation along the Main Drainage Ditch after the northern and northwestern ditches converge consists of shrubs and larger bushes, and the ditch itself contains vegetation, resulting in a wetlands area. The Main Compound itself consists of buildings, most of which are inactive, surrounded by grassy and paved areas.

Potential exposure pathways through which individuals could currently be exposed to COPCs at OU3 are discussed below and are presented in Table 3-10. Table 3-10 presents the exposure media, exposure points, potential receptors, and exposure routes; indicates whether the pathway is potentially complete; and identifies those pathways that are quantitatively evaluated.

#### **3.3.2.1 Sediment**

The most likely potential exposures to COPCs in sediment would be from trespassers who might trespass onto the facility or recreational users who may access the site and wade or play in or around the ditches. Although it is possible that trespassers might wade in OU3 ditches, there are other areas at WRF that are more appealing and would be more amenable to wading and playing. In addition, individuals conducting educational activities could be exposed to COPCs in sediment; however such exposures are currently limited and are similar to those of a trespasser/recreational user, thus were not evaluated under current land-use conditions. Workers are present at WRF under current land-use conditions, but none currently work in the OU3 ditches, and it is therefore unlikely that they would have any reason to contact sediment at OU3. Exposures to workers were therefore not evaluated under current land-use conditions. In summary, a trespasser/recreational user's contact exposures to sediment (i.e., via incidental ingestion and dermal absorption) from the PCBs and Pesticides Areas were quantitatively evaluated in the HHRA under current land-use conditions.

#### **3.3.2.2 Surface Water**

The most likely potential exposures to COPCs in surface water would be from trespassers who might trespass onto the facility, recreational users who could access the site and wade or play in the ditches, or environmental educators at OU3. Contact exposures to surface water (i.e., via dermal absorption) from OU3 were quantitatively evaluated in the HHRA for a trespasser/recreational user. Because the ditches are so shallow, swimming would not occur, thus incidental ingestion exposures for surface water were not evaluated. As noted above with sediment, an environmental educator's current exposures are limited, and would be similar to those experienced by trespassers/recreational users and were thus not evaluated under current land-use conditions. For the same reasons provided above for sediment, it is unlikely that contact exposures would occur for workers under current land-use conditions because workers would not likely frequent the ditches; therefore, exposures to these receptors were not evaluated in the HHRA.

#### **3.3.2.3 Fish**

Under current land-use conditions, it is not likely that individuals would fish from the OU3 ditches and consume their catch, when there are many other areas at WRF where the fishing would be much better. Therefore, although edible-sized fish were caught from the Main Drainage Ditch, ingestion of fish by individuals (e.g., trespassers, recreational users, or workers) under current land-use conditions was not quantitatively evaluated.

#### **3.3.2.4 Groundwater**

Groundwater at the site is not currently being used for drinking water or for any other purposes. As a result, exposures to groundwater would not occur under current land-use conditions, and were not evaluated in the HHRA.

#### **3.3.2.5 Surface Soil**

The most likely potential exposures to COPCs in soil would be from trespassers who might trespass onto the facility or recreational users who may access the site. In addition, individuals conducting educational activities could be exposed to COPCs in soil; however such exposures are

currently limited and are similar to those of a trespasser/recreational user, thus were not evaluated under current land-use conditions. Workers are present at WRF under current land-use conditions, but any workers would be present at OU3 to a limited degree, thus exposures to workers were therefore not evaluated under current land-use conditions. In summary, a trespasser/recreational user's contact exposures to surface soil (i.e., via incidental ingestion and dermal absorption) from the PCBs Area were quantitatively evaluated in the HHRA under current land-use conditions.

### **3.3.2.6 Summary of Pathways Selected for Evaluation Under Current Land-Use Conditions**

The exposure pathways quantitatively evaluated under current land-use conditions are the following:

- Incidental ingestion and dermal absorption of COPCs in sediment by a trespasser/recreational user;
- Dermal absorption of COPCs in surface water by a trespasser/recreational user; and
- Incidental ingestion and dermal absorption of COPCs in surface soil by a trespasser/recreational user.

### **3.3.3 Future Land-Use Conditions**

According to USEPA (1995b), an HHRA evaluating potential future exposures should reflect the most reasonably anticipated future land-uses. WRF will be transferred to the USFWS sometime in the near future. It is assumed that the land-use at the site would not likely change significantly, and the most likely receptors would be USFWS workers and visitors/students. In addition, environmental educators are likely to be at the site for longer periods of time than under current land-use conditions.

In addition, as requested by regulatory agencies and in order to provide a baseline understanding of worst-case risks at OU3, it was also assumed that WRF could become residential. In light of the transfer of WRF to the USFWS, this is considered highly unlikely; nevertheless, for the purposes of the HHRA, it was conservatively assumed that a resident lived at WRF. The future land-use scenarios evaluated in the HHRA assume that no remedial action occurs (i.e., the no action alternative).

Table 3-11 summarizes the potential exposure pathway analysis under future land-use conditions, and presents the exposure media, source and release mechanisms, potential receptors, exposure route, and whether or not the pathway is potentially complete for chemicals at or originating from the evaluated media at OU3.

#### **3.3.3.1 Sediment**

Even if WRF were to become residential in the future, it is unlikely that future residents would spend a significant amount of time contacting sediment. Nevertheless, for the purposes of the evaluation, it was assumed that child residents could come into contact with sediment on a regular basis while wading or playing and be exposed to COPCs in sediment via incidental ingestion and dermal absorption. Although adult residents also could be exposed to COPCs in sediment, their exposures are considered much more unlikely, since adults would not be as likely to wade/recreate in the ditches.

Workers could be exposed to COPCs in sediment under future land-use conditions. If any type of construction or maintenance work were to occur in the ditches, contact exposures (e.g., incidental ingestion and dermal absorption) to COPCs in sediment could occur. These pathways were therefore evaluated for future land-use conditions.

Environmental educators also could frequently be exposed to COPCs in sediment during future educational programs, thus contact exposures (e.g., incidental ingestion and dermal absorption) to COPCs in sediment were evaluated for future land-use conditions.

Other receptors, including visitors or students, could also contact sediment from the ditches in OU3. However, their exposures would likely be similar to those experienced by trespassers/recreational users, which were evaluated under current land-use conditions. Exposures to visitors and students were therefore not evaluated under future land-use conditions.

### **3.3.3.2 Surface Water**

Similar to sediment exposures, future child residents could be exposed to COPCs in surface water while wading or playing. Because the ditches are shallow, swimming could not occur; therefore, the only potential pathway through which children could be exposed would be via dermal absorption of COPCs in surface water. As noted above, adults would not be likely to frequent the ditches, thus exposures to surface water were not evaluated for hypothetical future adult residents.

Workers could be exposed to COPCs in surface water under future land-use conditions. However, it is unlikely that much work would be conducted with significant water in the ditches. Furthermore, if workers were to contact surface water, the likelihood of significant contact would be quite small, because they would likely wear boots, minimizing surface water contact. Therefore, worker exposures to COPCs in surface water were not evaluated for future land-use conditions.

Environmental educators also could be exposed to COPCs in surface water during future educational programs, thus dermal contact exposures to COPCs in surface water were evaluated for future land-use conditions. As noted above, only dermal exposures would be likely, since the ditches are too shallow for incidental ingestion exposures to occur.

As noted above, other receptors at OU3 ditches include visitors or students. Although they also could contact surface water from the ditches in OU3, their exposures would likely be similar to those experienced by trespassers/recreational users, which were evaluated under current land-use conditions. Exposures to visitors and students were therefore not evaluated again under future land-use conditions.

### **3.3.3.3 Fish**

As noted earlier, fish tissue samples were collected from the PCBs Area at OU3. If residents were to live at WRF, it is possible that they could fish from this area and consume their catch. Although this is unlikely, considering that fishing in the bay, pond, and creeks at WRF would be much more appealing, for the purposes of the HHRA, it was assumed that future residents would hypothetically consume fish caught from the Main Drainage Ditch. Only adults were evaluated for this pathway, since it was assumed that young children would not consume significant amounts of fish.

Although future workers or visitors/students/recreational users could fish at the Main Drainage Ditch, it would not be a very likely exposure scenario, since these receptors would more likely fish in better locations, such as Occoquan Bay and Marumsco Creek. In addition, because this pathway is being evaluated for hypothetical future residents whose exposures would be greater than those of workers or visitors/students/recreational users, ingestion of fish only by future adult residents was evaluated.

### **3.3.3.4 Groundwater**

Future child and adult residents were assumed to be exposed to COPCs in groundwater. Potentially complete exposure pathways for both child and adult residents include ingestion of drinking water and dermal absorption of COPCs in groundwater while bathing. In addition, inhalation of VOCs while showering only by adults (since young children would not be as likely to take showers) was considered for evaluation. However, because none of the COPCs selected for evaluation in groundwater were VOCs, inhalation exposures while showering were not evaluated in the HHRA.

If drinking water wells were installed and the site were industrial in nature, workers at OU3 could potentially be exposed to COPCs in groundwater via ingestion. Although dermal exposures also could occur (while washing hands, for example), these exposures would not be as significant due to the small surface area (hands and forearms) and infrequent exposure frequency.

It should be noted that the use of groundwater in the future is considered to be highly unlikely, due to high iron levels, necessitating treatment prior to consumption.

### **3.3.3.5 Surface Soil**

Future child and adult residents were assumed to contact and be exposed to COPCs in surface soil from the PCBs Area grouping. Children could contact COPCs in surface soil while playing, while adults could contact COPCs in surface soil while gardening or performing other activities. Potentially

complete exposure pathways for child and adult residents for surface soil in both areas would be incidental ingestion of soil and dermal absorption of chemicals in soil. Therefore, both pathways were evaluated for hypothetical future child and adult residents. Inhalation exposures were not evaluated for surface soil, since areas are typically paved or grassy, and generation of particulate matter would not occur to a significant degree.

Workers at OU3 could potentially be exposed to COPCs in surface soil while performing maintenance or other activities, thus incidental ingestion and dermal absorption exposures were evaluated for this receptor. In addition, environmental educators at OU3 also could be exposed to COPCs in surface soil during future educational programs. Consequently, incidental ingestion and dermal absorption exposures also were evaluated for this receptor under future land-use conditions.

### **3.3.3.6 Summary of Pathways Selected for Evaluation Under Potential Future Land-Use Conditions**

The exposure pathways quantitatively evaluated under assumed potential future land-use conditions are as follows:

- Incidental ingestion and dermal absorption of COPCs in sediment by child residents;
- Dermal absorption of COPCs in surface water by child residents;
- Incidental ingestion and dermal absorption of COPCs in sediment by workers;
- Incidental ingestion and dermal absorption of COPCs in sediment by environmental educators;
- Dermal absorption of COPCs in surface water by environmental educators;
- Ingestion of fish by adult residents;
- Incidental ingestion and dermal absorption of COPCs in surface soil by child residents;
- Incidental ingestion and dermal absorption of COPCs in surface soil by adult residents;
- Incidental ingestion and dermal absorption of COPCs in surface soil by workers;
- Incidental ingestion and dermal absorption of COPCs in surface soil by environmental educators;
- Ingestion and dermal absorption of COPCs in groundwater by child residents;
- Ingestion and dermal absorption of COPCs groundwater by adult residents; and
- Ingestion of COPCs in groundwater by workers.

### **3.3.4 Quantification of Exposure**

To quantitatively assess potential exposures to COPCs at OU3, estimates of environmental concentrations at the exposure points were combined with information describing the extent, frequency, and duration of exposure for each potential receptor. This section presents how exposure point concentrations were calculated, followed by an overview of the approaches used to quantify exposures for each selected exposure pathway. The approaches used in this section to quantify exposures are consistent with USEPA (1989a, 1992a) guidance.

#### **3.3.4.1 Exposure Point Concentrations**

In order to estimate potential exposures and risks associated with site-related chemicals, chemical concentrations at the points of exposure were first determined. According to USEPA (1992a,c), the most appropriate measurement of central tendency for environmental chemical concentrations is the arithmetic mean. To account for uncertainty associated with this value, USEPA guidance requires the use of the 95% upper confidence limit (UCL) on the arithmetic mean concentration for the estimation of the RME risk. The term RME is defined as the maximum exposure that is reasonably expected to occur at a site (USEPA 1989a). The methodology for calculating the UCL for logtransformed data, which is

discussed by Gilbert (1987) and Land (1975), and is presented in USEPA guidance documents (1992a,c), is as follows:

$$UCL_{1-\alpha} = \exp(y + 0.5 s_y^2 = \frac{S_y * H_{1-\alpha}}{\sqrt{n-1}})$$

where:

UCL = upper confidence limit;  
 $\alpha$  = probability of error (0.05);  
 $y$  = mean of the transformed data;  
 $s_y$  = standard deviation of the transformed data;  
 $(s_y)^2$  = variance of the data;  
 $H$  = H-statistic (i.e., from Gilbert 1987); and  
 $n$  = number of samples in population.

When the 95% UCL exceeds the maximum measured value, USEPA (1989a) directs that the maximum measured value be used as the exposure point concentration.

As discussed earlier in Section 3.2, the 95% UCL on the arithmetic mean was calculated for each chemical by including nondetects at one-half of their sample-specific quantitation limits. The RME concentrations of each COPC were assumed to represent the concentrations to which receptors could be exposed at OU3. Exposure point concentrations for the COPCs in the sampled media (i.e., sediment, surface water, fish, groundwater, and surface soil) are presented in Table 3-12.

#### 3.3.4.2 Exposure Estimates Under Current Land-Use Conditions

For the ingestion and dermal absorption exposure pathways, quantification of exposure involves the estimation of an average daily dose, expressed in units of mg chemical/kg body weight per day (mg/kg-day). Dose can be defined as an exposure rate to a chemical determined over an exposure period per unit body weight, and is calculated similarly for both ingestion and dermal absorption pathways. There are, however, significant differences in the meaning and terms used to describe dose for the ingestion and dermal pathways. For the ingestion exposure pathways, the doses calculated in this assessment are referred to as "potential doses." The potential dose is the amount of chemical ingested and available for uptake in the body, and is analogous to the administered dose in a dose-response toxicity experiment. For the dermal absorption pathways, the estimated dose is referred to as an "internal dose," and reflects the amount of chemical that has been absorbed into the body and is available for interaction with biologically important tissues.

Average daily doses are estimated differently for chemicals exhibiting noncarcinogenic and carcinogenic effects, since different toxicity criteria are available for carcinogenic effects and noncarcinogenic effects of chemicals (see Section 3.4, Toxicity Assessment). Average daily doses (ADD) for noncarcinogens are averaged over the duration of exposure and, following USEPA (1992a) guidance, are given the acronym ADD for average daily dose. Average daily doses for carcinogens are averaged over a lifetime, and are given the acronym LADD for lifetime average daily dose. LADDs and ADDs for ingestion exposures, or potential doses, are indicated by (L)ADD<sub>pot</sub>, while LADDs and ADDs for dermal exposures, or internal doses, are indicated by (L)ADD<sub>int</sub>.

The ADDs and LADDs are estimated using exposure point concentrations of chemicals together with exposure parameters that specifically describe the exposure pathway. ADDs and LADDs for each pathway were derived by combining the selected exposure point concentration (based on the maximum or the 95% UCL on the mean concentration) of each chemical with reasonable maximum values describing the extent, frequency, and duration of exposure (USEPA, 1989a, 1992a).

The following sections present equations by which (L)ADDs were calculated for those pathways quantitatively evaluated under current land-use conditions. The assumptions associated with calculating these exposures and the equations used to estimate ADDs<sub>pot</sub> and LADDs<sub>pot</sub> for ingestion exposures and ADDs<sub>int</sub> and LADDs<sub>int</sub> for dermal absorption exposures are provided below. It was conservatively

assumed that the chemical concentrations in sediment, surface water, and fish would remain constant over the exposure period.

#### **3.3.4.2.1 Incidental Ingestion of Sediment by Trespassers/Recreational Users**

Exposures for incidental ingestion of chemicals in sediment by trespassers/recreational users were calculated using the equation and the exposure parameters presented in Table 3-13 and discussed below.

The sediment exposure point concentrations that were used to evaluate ingestion exposures are shown in Table 3-12 for both the PCBs and Pesticides Areas. The standard default value for a soil ingestion rate (100 mg/day) recommended by USEPA (1989a, 1991a) for individuals over the age of six was used for calculating potential incidental ingestion exposures of sediment for trespassers/recreational users at OU3. The age period assumed for trespassers/recreational users was seven to 16 years old. Trespassers/recreational users were conservatively assumed to be at OU3 one time per week during the year (minus two weeks per year away from the home), resulting in a total of 50 days/year. The exposure duration was assumed to be 10 years, based on the age duration evaluated.

One of the several factors affecting the dose calculation for sediment ingestion is a chemical's bioavailability. Ingested chemicals present in a sediment matrix may not be as readily absorbed through the gastrointestinal tract (due to their affinity to the sediment particles) as chemicals ingested in the matrices administered in experimental studies (from which toxicity criteria are derived). The differences in absorption expected between the ingestion of chemicals adsorbed onto sediment in comparison with typical toxicological study conditions can be accounted for by incorporating a bioavailability factor into the exposure equation. However, for this assessment, the bioavailability factors for all the COPCs were conservatively assumed to be 1.0 (assuming that the absorption efficiency was equivalent for the toxicological study matrix and the sediment matrix).

A 50<sup>th</sup> percentile body weight value of 45 kg for a 7-to-16 year old was used, and was based on age- and gender-weighted data provided in USEPA (1985b). The USEPA (1989a, 1991a) standard default of 70 years for a lifetime was used as the averaging time for carcinogenic exposures. To calculate the potential for noncarcinogenic exposures, the averaging time was the duration of exposure (i.e., 10 years for the 7-to-16 year old).

The RME exposure point concentrations and calculated LADDs for carcinogenic effects due to the incidental ingestion of sediment by trespassers/recreational users are summarized in the Risk Characterization section.

#### **3.3.4.2.2 Dermal Absorption of Chemicals in Sediment by Trespassers/Recreational Users**

Exposures due to dermal absorption of chemicals in sediment were estimated using the equation and the exposure parameters presented in Table 3-14 and discussed below.

The chemical concentrations in sediment, as well as the parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used for estimating the ingestion of sediment by a trespasser/recreational user.

Parameters that are specific to the dermal exposure scenario include the area of exposed skin, the amount of sediment adhering to the skin, and amount of chemical absorbed through the skin from sediment. For the trespasser/recreational user scenario, it was assumed that the trespasser's/recreational user's hands, ½ arms (e.g., forearms), ½ legs (e.g., lower legs), and feet would be exposed and available for contact with sediment. Using data from USEPA (1985a), and averaging across gender and age; it was estimated that the exposed skin surface area for 7-to-16 year old trespassers/recreational users would be 4,600 cm<sup>2</sup>. Because no sediment-to-skin adherence factor exists, the soil-to-skin adherence factor of 1.0 mg/cm<sup>2</sup>-day was used, which is the reasonable upper-bound default value estimated by USEPA (1992b).

The amount of chemical in sediment absorbed through the skin must be estimated in order to calculate dermal doses. For a chemical to be absorbed through the skin from sediment, it must be released from the sediment matrix, pass through the layers of the skin, and enter into the systemic circulation. This series of events is dependent on a number of factors including the characteristics of the

chemical, the concentration in the applied dose, the site of exposure, inter-individual variability, and characteristics of sediment (e.g., particle size and organic carbon content). Data regarding the amount of specific chemicals that may be absorbed through the skin under conditions normally encountered in the environment (and assumed to occur for this assessment) are lacking. While a number of approaches have been developed to estimate absorption of compounds from the sediment matrix, the resulting dose estimates are highly uncertain (USEPA, 1992b). Despite this uncertainty, the dermal absorption factors for COPCs obtained from USEPA (1995c) were used and are presented in Table 3-14.

The RME exposure point concentrations and calculated LADDs for carcinogenic effects due to dermal absorption of COPCs in sediment at the PCBs and Pesticides Areas by trespassers/recreational users are summarized in the Risk Characterization section.

### 3.3.4.2.3 Dermal Absorption of Chemicals in Surface Water by Trespassers/Recreational Users

Dermal absorption of chemicals while wading were calculated for COPCs in the PCBs and Pesticides Areas surface water by using the equation and exposure parameters presented in Table 3-15.

The surface water concentrations to which trespassers/recreational users could be exposed while wading were presented earlier in Table 3-12. Although chemicals in the dissolved phase would more readily be absorbed into the skin, as opposed to chemicals in the particulate phase, dissolved surface water concentrations were not available for any of the COPCs, and the more conservative total surface water concentrations were used to evaluate dermal absorption of chemicals from surface water. When estimating potential trespasser/recreational user dermal exposures while wading, the surface area was assumed to be 4,600 cm<sup>2</sup>, (the same as the body surface area for the sediment dermal absorption pathway). It was also assumed that the trespasser/recreational user contacts surface water one time per day, for each of the 50 days at the site. An exposure duration of 10 years for the trespasser/recreational user was used, based on the trespasser/recreational user's age duration being evaluated.

A body weight of 45 kg for a 7-16 year old was used, based on data summarized in USEPA (1985b). The USEPA (1989a, 1991a) standard default value of 70 years for a lifetime was used as the averaging time for calculating carcinogenic exposures, while the averaging time for calculating noncarcinogenic exposures was equal to the duration of exposure (i.e., 10 years).

The dose absorbed (DA) per unit area per event is a function of chemical concentration in water, the permeability coefficient for that chemical from water through the skin, and exposure time. The DA value is calculated differently, depending on whether a steady-state or nonsteady-state approach is used. Following USEPA (1992b) guidance, a steady-state approach should be used to evaluate dermal absorption of inorganics from an aqueous matrix, while a nonsteady-state approach has been recommended to evaluate dermal absorption of organics in an aqueous matrix. Because no organic COPCs were selected for evaluation in surface water, only the methodology for determining absorption of inorganic chemicals from surface water is presented.

When calculating the absorbed dose for inorganics assuming steady-state conditions, it is assumed that the concentration gradient across all skin layers is constant and the rate that a chemical enters the skin equals the rate that it exits. Under these assumptions, DA can be estimated using the following steady-state equation from USEPA (1992b):

$$DA = C_{SW} * CF_1 * CF_2 * PC * ET$$

where:

- DA = dose absorbed per unit area per event (mg/cm<sup>2</sup>-event);
- C<sub>SW</sub> = chemical concentration in surface water (µg/L);
- CF<sub>1</sub> = conversion factor (1 L/10<sup>3</sup> cm<sup>3</sup>);
- CF<sub>2</sub> = conversion factor (1 mg/10<sup>3</sup> µg);
- PC = chemical-specific dermal permeability coefficient (cm/hr); and
- ET = exposure time (hours/event).

The RME surface water concentrations that were used for the dermal pathway were presented earlier on Table 3-12. The permeability coefficient is defined as a flux value, normalized for concentrations, that represents the rate at which a chemical penetrates the skin (in units of cm/hr). The default permeability coefficient for inorganics was used for all evaluated inorganics (i.e.,  $10^{-3}$  cm/hr [USEPA, 1992b]). The assumed exposure time for contact with water was 2 hours/event.

The RME exposure point concentrations and resulting ADDs for noncarcinogenic effects of a trespasser/recreational user's dermal absorption of chemicals in surface water while wading are summarized in the Risk Characterization section.

#### **3.3.4.2.4 Incidental Ingestion of Surface Soil by Trespassers/Recreational Users**

Exposures for incidental ingestion of chemicals in surface soil for trespassers/recreational users were calculated using the equation and exposure parameters presented earlier in Table 3-13 and discussed below.

The surface soil exposure point concentrations that were used to evaluate ingestion exposures are shown in Table 3-12. The standard default value for a soil ingestion rate (100 mg/day) recommended by USEPA (1991a) for individuals over the age of six was used for calculating potential incidental ingestion exposures for trespassers/recreational users. The parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used for estimating incidental ingestion of sediment by a trespasser/recreational user. The bioavailability factors for all the COPCs were conservatively assumed to be 1.0 (assuming that the absorption efficiency was equivalent for the toxicological study matrix and the sediment matrix).

The calculated LADDs for carcinogenic effects and ADDs for noncarcinogenic effects due to the incidental ingestion of surface soil by trespassers/recreational users are summarized in the Risk Characterization section.

#### **3.3.4.2.5 Dermal Absorption of Chemicals in Surface Soil by Trespassers/Recreational Users**

Internal doses due to dermal absorption of chemicals in surface soil were estimated using the equation and exposure parameters discussed below and presented earlier in Table 3-14.

The chemical concentrations in surface soil, as well as the parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used above when estimating incidental ingestion of surface soil by trespassers/recreational users.

Parameters that are specific to the dermal exposure scenarios include the area of exposed skin, the amount of soil adhering to the skin, and amount of chemical absorbed through the skin from soil. For the trespasser/recreational user scenario, it was assumed that the hands,  $\frac{1}{2}$  arms (i.e., forearms),  $\frac{1}{2}$  legs (i.e., lower legs), and feet would be exposed and available for contact with soil. Using data from USEPA (1985), and averaging across gender and age, it was estimated that the exposed skin surface area would be 4,600 cm<sup>2</sup>, respectively. The soil-to-skin adherence factor was assumed to be 1.0 mg/cm<sup>2</sup>-event, the reasonable upper-bound default value estimated by USEPA (1992b). Dermal absorption factors used for the dermal pathway are presented in Table 3-14.

The resulting LADDs for carcinogenic effects and ADDs for the noncarcinogenic effects due to dermal absorption of COPCs in soil are summarized in the Risk Characterization section.

#### **3.3.4.3 Exposure Estimates Under Future Land-Use Conditions**

The following sections present equations by which (L)ADDs were calculated for those pathways quantitatively evaluated under hypothetical future land-use conditions. The assumptions and the equations used to estimate (L)ADDs are provided below, by pathway. It was assumed that the chemical concentrations would remain constant over the exposure period.

##### **3.3.4.3.1 Incidental Ingestion of Sediment by Workers**

Exposures for incidental ingestion of chemicals in sediment for hypothetical future workers were calculated using the equation and exposure parameters presented in Table 3-16 and discussed below.



The sediment exposure point concentrations to which workers could be exposed were presented earlier on Table 3-12. As noted earlier, it was assumed that future workers could conduct maintenance or construction activities in the OU3 ditches. As a result, the standard default value for a worker's short-term outdoor ingestion exposure for industrial/commercial facilities (480 mg/day) recommended by USEPA (1991a) was used for calculating potential incidental ingestion exposures for future workers. Workers were conservatively assumed to be working and potentially contacting sediment at OU3 for about two months while construction/maintenance activities were taking place, resulting in an exposure frequency of 50 days/year. In addition, the worker was assumed to work in the OU3 ditches on a one-time basis, resulting in an exposure duration of one year. Bioavailability factors were assumed to be 1.0.

An average body weight value of 70 kg for an adult was used for the worker, and is based on data provided in USEPA (1989a, 1991a). The USEPA (1989a, 1991a) standard default of 70 years for a lifetime was used as the averaging time for carcinogenic exposures. To calculate the potential for noncarcinogenic exposures, the averaging time was the duration of exposure (i.e., one year).

The RME exposure point concentrations and calculated LADDs for carcinogenic effects due to the incidental ingestion of sediment by workers are summarized in the Risk Characterization section for both the PCBs and Pesticides Areas.

#### **3.3.4.3.2 Dermal Absorption of Chemicals in Sediment by Workers**

Exposures due to dermal absorption of chemicals in sediment by workers were estimated using the equation and exposure parameters discussed below and presented on Table 3-17.

The chemical concentrations in sediment, as well as the parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used for estimating the ingestion of sediment by a worker.

Parameters that are specific to the dermal exposure scenario include the area of exposed skin, the amount of sediment adhering to the skin, and amount of chemical absorbed through the skin from sediment. For the worker scenario, it was assumed that the worker's hands and arms would be exposed and available for contact with sediment. This assumption was based on the likelihood that workers would be wearing pants, but may have their hands and arms exposed. Using data from USEPA (1985b), and averaging across gender and age, it was estimated that the exposed skin surface area for workers would be 3,500 cm<sup>2</sup>. Because no sediment-to-skin adherence factor exists, the soil-to-skin adherence factor of 1.0 mg/cm<sup>2</sup>-day, which is the reasonable upper-bound default value estimated by USEPA (1992b), was used. As noted earlier, the amount of chemical in sediment absorbed through the skin must be estimated in order to calculate dermal doses. Dermal absorption factors for COPCs were obtained from USEPA (1995c), and are shown in Table 3-17.

The RME exposure point concentrations and calculated LADDs for carcinogenic effects due to dermal absorption of chemicals in sediment by workers are summarized in the Risk Characterization section.

#### **3.3.4.3.3 Incidental Ingestion of Sediment by Environmental Educators**

Exposures for incidental ingestion of chemicals in sediment for hypothetical future environmental educators were calculated using the equation and exposure parameters presented in Table 3-18 and discussed below.

The sediment exposure point concentrations to which environmental educators could be exposed were presented earlier on Table 3-12. As noted earlier, it was assumed that future environmental educators could be present at the OU3 ditches conducting educational activities. As a result, the standard default value for an adult's incidental ingestion soil exposure of 100 mg/day (USEPA, 1991a) was used for calculating potential incidental sediment ingestion exposures for future environmental educators. These individuals were conservatively assumed to be potentially contacting sediment at OU3 for 250 days/year, which assumes that they are present at OU3 for 5 days/week, 50 weeks/year (USEPA, 1991a). In addition, the environmental educator was assumed to work as an educator at OU3 for 25 years, which is the upper-bound default value for time spent at one job (USEPA, 1991a). Bioavailability factors were assumed to be 1.0.

An average body weight value of 70 kg for an adult was used for the educator, and is based on data provided in USEPA (1989a, 1991a). The USEPA (1989a, 1991a) standard default of 70 years for a lifetime was used as the averaging time for carcinogenic exposures. To calculate the potential for noncarcinogenic exposures, the averaging time was the duration of exposure (i.e., 25 years).

The RME exposure point concentrations and calculated LADDs for carcinogenic effects due to the incidental ingestion of sediment by environmental educators are summarized in the Risk Characterization section for both the PCBs and Pesticides Areas.

#### **3.3.4.3.4 Dermal Absorption of Chemicals in Sediment by Environmental Educators**

Exposures due to dermal absorption of chemicals in sediment by environmental educators were estimated using the equation and exposure parameters discussed below and presented on Table 3-19.

The chemical concentrations in sediment, as well as the parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used for estimating the ingestion of sediment by an educator.

Parameters that are specific to the dermal exposure scenario include the area of exposed skin, the amount of sediment adhering to the skin, and amount of chemical absorbed through the skin from sediment. For the environmental educator scenario, as for the worker scenario, it was assumed that the educator's hands and arms would be exposed and available for contact with sediment. This assumption was based on the likelihood that the individuals would be wearing pants, but may have their hands and arms exposed. Using data from USEPA (1985b), and averaging across gender and age, it was estimated that the exposed skin surface area would be 3,500 cm<sup>2</sup>. Because no sediment-to-skin adherence factor exists, the soil-to-skin adherence factor of 1.0 mg/cm<sup>2</sup>-day, which is the reasonable upper-bound default value estimated by USEPA (1992b), was used. As noted earlier, the amount of chemical in sediment absorbed through the skin must be estimated in order to calculate dermal doses. Dermal absorption factors for COPCs were obtained from USEPA (1995c), and are shown in Table 3-19.

The RME exposure point concentrations and calculated LADDs for carcinogenic effects due to dermal absorption of chemicals in sediment by environmental educators are summarized in the Risk Characterization section.

#### **3.3.4.3.5 Incidental Ingestion of Sediment by Child Residents**

Exposures for incidental ingestion of chemicals in sediment for hypothetical future 1-to-6 year old child residents were calculated using the equation and exposure parameters presented in Table 3-20 and discussed below.

The sediment exposure point concentrations that were used to evaluate ingestion exposures for both sediment groupings are shown in Table 3-12. The standard default value for a soil ingestion rate of 200 mg/day (USEPA, 1989a, 1991a) for children under six was used to evaluate incidental ingestion exposures of sediment for children. The exposure frequency for child residents playing/wading in the OU3 ditches was assumed to be 100 days/year, based on exposures two days/week for 50 weeks/year. The exposure duration for children was assumed to be six years, based on the age period evaluated. As noted earlier, the bioavailability factors for all the COPCs were conservatively assumed to be 1.0.

An average body weight value of 15 kg for children was obtained from USEPA (1991a). The USEPA (1989a, 1991a) standard default of 70 years for a lifetime was used as the averaging time for carcinogenic exposures, while the duration of exposure (i.e., six years) was used as the averaging time for calculating the noncarcinogenic exposures.

The RME exposure point concentrations and calculated LADDs for carcinogenic effects due to the incidental ingestion of sediment by hypothetical future child residents are summarized in the Risk Characterization section.

#### **3.3.4.3.6 Dermal Absorption of Chemicals in Sediment by Child Residents**

Exposures due to dermal absorption of chemicals in sediment were estimated for hypothetical future child residents using the equation and exposure parameters discussed below and presented on Table 3-21.

The chemical concentrations in sediment, as well as the parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used above when estimating incidental ingestion of sediment by hypothetical future child residents at OU3.

As noted earlier, parameters that are specific to the dermal exposure scenarios include the area of exposed skin, the amount of sediment adhering to the skin, and amount of chemical absorbed through the skin from sediment. For the child resident exposure scenario, it was assumed that the child's hands, ½ arms (e.g., forearms), ½ legs (e.g., lower legs), and feet could be exposed and available for contact with sediment. Based on data provided in USEPA (1985b), the resulting body surface area was 2,200 cm<sup>2</sup>. Because no sediment-to-skin adherence factor exists, the soil-to-skin adherence factor of 1.0 mg/cm<sup>2</sup>-event, which is the reasonable upper-bound default value estimated by USEPA (1992b), was used. The amount of chemical in sediment absorbed through the skin must be estimated in order to calculate dermal doses. The dermal absorption factors for COPCs are presented in Table 3-21, and were obtained from USEPA (1995c).

The RME exposure point concentrations and resulting LADDs for carcinogenic effects due to dermal absorption of COPCs in sediment at OU3 are summarized in the Risk Characterization section for hypothetical future child residents.

#### **3.3.4.3.7 Dermal Absorption of Chemicals in Surface Water by Environmental Educators**

Dermal absorption of chemicals in surface water for environmental educators was calculated by using the equation and exposure parameters presented in Table 3-22 and discussed below.

The surface water RME exposure point concentrations to which educators could be exposed are presented on Table 3-12. When estimating potential dermal exposures, the body surface area that was used in the evaluation was 3,500 cm<sup>2</sup> (the same body surface area used for the sediment dermal absorption pathway). In addition, it was assumed that the educator is exposed to surface water in the ditches 100 days/year. Environmental educators were assumed to contact surface water in the ditches one time per day (i.e., one event/day). An exposure duration of 25 years was used, which is the upper bound value for time spent at one job (USEPA 1991a).

A body weight of 70 kg for an adult was obtained from USEPA (1991a). The USEPA (1989a, 1991a) standard default of 70 years for a lifetime was used as the averaging time to calculate carcinogenic exposures, while the duration of exposure (i.e., 25 years) was used as the averaging time to calculate noncarcinogenic exposures.

As described earlier, the DA per unit area per event is a function of chemical concentration in water, the permeability coefficient for that chemical from water through the skin, and exposure time. Inorganics were assumed to have default permeability coefficients of 10<sup>-3</sup> cm/hr (USEPA 1992b), and the exposure time was assumed to be two hours/event.

The RME exposure point concentrations and resulting ADDs for noncarcinogenic effects of an environmental educator's dermal absorption of chemicals in surface water are summarized in the Risk Characterization section.

#### **3.3.4.3.8 Dermal Absorption of Chemicals in Surface Water by Child Residents**

Dermal absorption of chemicals while wading in surface water for hypothetical future child residents were calculated by using the equation and exposure parameters presented in Table 3-23 and discussed below.

The surface water RME exposure point concentrations to which child residents could be exposed are presented on Table 3-12. When estimating potential child dermal exposures while wading, the body surface area that was used in the evaluation was 2,200 cm<sup>2</sup> for the 1-to-6 year old (the same body surface area was used for the sediment dermal absorption pathway). In addition, it was assumed that the child wades in the ditches 100 days/year, based on exposures two days/week for 50 weeks/year. Children were assumed to play in the ditches one time per day (i.e., one event/day). An exposure duration of six years was used for a child, based on the child's age duration being evaluated.

A body weight of 15 kg for a 1-6 year old was obtained from USEPA (1991a). The USEPA (1989a, 1991a) standard default of 70 years for a lifetime was used as the averaging time to calculate carcinogenic exposures, while the duration of exposure (i.e., six years) was used as the averaging time to calculate noncarcinogenic exposures.

As described earlier, the DA per unit area per event is a function of chemical concentration in water, the permeability coefficient for that chemical from water through the skin, and exposure time. Inorganics were assumed to have default permeability coefficients of  $10^{-3}$  cm/hr (USEPA 1992b), and the exposure time was assumed to be two hours/event.

The RME exposure point concentrations and resulting ADDs for noncarcinogenic effects of a child's dermal absorption of chemicals in surface water are summarized in the Risk Characterization section.

#### **3.3.4.3.9 Ingestion of Fish by Adult Residents**

Exposures for ingestion of chemicals in fish for hypothetical future adult residents were calculated using the equation and exposure parameters presented in Table 3-24 and discussed below.

The fillet fish tissue exposure point concentrations that were used to evaluate ingestion exposures for all species of fish caught at OU3 are shown in Table 3-12. An ingestion rate of 54 grams/day (which is based on recreational fishing) was obtained from USEPA (1991a) and is used along with an exposure frequency of 350 days/year. The combination of this ingestion rate and exposure frequency is equivalent to two 8-ounce servings of fish per week. Because the OU3 ditch supports small fish (i.e., sunfish were about 4 inches long and about 1-2 ounces; crappie were about 6 inches long, and about 1-3 ounces; carp were about 10-13 inches long and about 12-23 ounces; and eel were about 7-10 inches long and about 1 ounce [see Section 4.0 for more discussion on fish lengths and weights for fish caught at OU3]), it is highly unlikely that it would contain enough fish for hypothetical future residents to consume fish from OU3 at the default recreational fishing exposure rates. Considering that the fillet portion of the fish that would most likely be consumed accounts for less than 50% of the total body weight, it is clear that these fish would not be used for significant consumption. Therefore, the default recreational fishing exposure parameters were adjusted by one-half to reflect lower ingestion rates that would be more relevant for the exposure scenario at the site (i.e., 175 days/year). The exposure duration for adults was assumed to be 30 years, which is the upper-bound value for residential tenure at one residence (USEPA, 1989a, 1991a).

An average body weight value of 70 kg for adults was obtained from USEPA (1989a, 1991a). The USEPA (1989a, 1991a) standard default of 70 years for a lifetime was used as the averaging time for carcinogenic exposures, while the duration of exposure (i.e., 30 years) was used as the averaging time for calculating the noncarcinogenic exposures.

The RME exposure point concentrations and calculated LADDs for carcinogenic effects and ADDs for noncarcinogenic effects due to the ingestion of fish by hypothetical future adult residents are summarized in the Risk Characterization section.

#### **3.3.4.3.10 Incidental Ingestion of Surface Soil by Workers.**

Exposures for incidental ingestion of chemicals in surface soil for hypothetical future workers were calculated using the equation and exposure parameters presented in Table 3-25 and discussed below.

The surface soil exposure point concentrations that were used to evaluate ingestion exposures are shown in Table 3-12. The standard default value for a worker soil ingestion rate (50 mg/day) recommended by USEPA (1991a) was used for calculating potential incidental ingestion exposures for worker. The exposure frequency for a worker was assumed to be 250 days/year, a standard default USEPA (1991a) value, assuming exposures five days/week for 50 weeks/year. The exposure duration for adults was assumed to be 25 years, which is the upper-bound value for workers at one job (USEPA, 1991a). Bioavailability factors were assumed to be 1.0.

An average body weight value of 70 kg for an adult was used for the worker, and is based on data provided in USEPA (1989a, 1991a). The USEPA (1989a, 1991a) standard default of 70 years for a

lifetime was used as the averaging time for carcinogenic exposures. To calculate the potential for noncarcinogenic exposures, the averaging time was the duration of exposure (i.e., 25 years).

The RME exposure point concentrations and calculated LADDs for carcinogenic effects due to the incidental ingestion of soil by workers are summarized in the Risk Characterization section.

#### **3.3.4.3.11 Dermal Absorption of Chemicals in Surface Soil by Workers.**

Internal doses due to dermal absorption of chemicals in surface soil were estimated using the equation and exposure parameters discussed below and presented on Table 3-26.

The chemical concentrations in surface soil, as well as the parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used above when estimating incidental ingestion of surface soil by hypothetical future workers.

Parameters that are specific to the dermal exposure scenario include the area of exposed skin, the amount of soil adhering to the skin, and amount of chemical absorbed through the skin from soil. For the worker scenario, it was assumed that the worker's hands and arms would be exposed and available for contact with soil. This assumption was based on the likelihood that workers would be wearing pants, but may have their hands and arms exposed. Using data from USEPA (1985b), and averaging across gender and age, it was estimated that the exposed skin surface area for workers would be 3,500 cm<sup>2</sup>. The soil-to-skin adherence factor of 1.0 mg/cm<sup>2</sup>-day, which is the reasonable upper-bound default value estimated by USEPA (1992b), was used. As noted earlier, the amount of chemical in soil absorbed through the skin must be estimated in order to calculate dermal doses. Dermal absorption factors for COPCs were obtained from USEPA (1995c), and are shown in Table 3-26.

The resulting LADDs for carcinogenic effects and ADDs for the noncarcinogenic effects due to dermal absorption of COPCs in soil are summarized in the Risk Characterization section.

#### **3.3.4.3.12 Incidental Ingestion of Surface Soil by Environmental Educators.**

Exposures for incidental ingestion of chemicals in surface soil for hypothetical future environmental educators were calculated using the equation and exposure parameters presented earlier in Table 3-18 and discussed below.

The soil exposure point concentrations to which environmental educators could be exposed were presented earlier on Table 3-12. As noted earlier, it was assumed that future environmental educators could be present at the OU3 conducting educational activities. As a result, the standard default value for an adult's incidental ingestion soil exposure of 100 mg/day (USEPA, 1991a) was used for calculating potential incidental ingestion exposures for future environmental educators. These individuals were conservatively assumed to be potentially contacting sediment at OU3 for 250 days/year, which assumes that they are present at OU3 for 5 days/week, 50 weeks/year (USEPA 1991a). In addition, the environmental educator was assumed to work as an educator at OU3 for 25 years, which is the upper-bound default value for time spent at one job (USEPA 1991a). Bioavailability factors were assumed to be 1.0.

An average body weight value of 70 kg for an adult was used for the educator, and is based on data provided in USEPA (1989a, 1991a). The USEPA (1989a, 1991a) standard default of 70 years for a lifetime was used as the averaging time for carcinogenic exposures. To calculate the potential for noncarcinogenic exposures, the averaging time was the duration of exposure (i.e., 25 years).

The calculated LADDs for carcinogenic effects and ADDs for noncarcinogenic effects due to the incidental ingestion of surface soil by hypothetical future residents are summarized in the Risk Characterization section.

#### **3.3.4.3.13 Dermal Absorption of Chemicals in Surface Soil by Environmental Educators.**

Internal doses due to dermal absorption of chemicals in surface soil were estimated using the equation and exposure parameters discussed below and presented earlier in Table 3-19.

The chemical concentrations in surface soil, as well as the parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used above when estimating incidental ingestion of surface soil by hypothetical future environmental educators.

Parameters that are specific to the dermal exposure scenario include the area of exposed skin, the amount of soil adhering to the skin, and amount of chemical absorbed through the skin from soil. For the environmental educator scenario, as for the worker scenario, it was assumed that the educator's hands and arms would be exposed and available for contact with soil. This assumption was based on the likelihood that the individuals would be wearing pants, but may have their hands and arms exposed. Using data from USEPA (1985b), and averaging across gender and age, it was estimated that the exposed skin surface area would be 3,500 cm<sup>2</sup>. The soil-to-skin adherence factor of 1.0 mg/cm<sup>2</sup>-day, which is the reasonable upper-bound default value estimated by USEPA (1992b), was used. As noted earlier, the amount of chemical in soil absorbed through the skin must be estimated in order to calculate dermal doses. Dermal absorption factors for COPCs were obtained from USEPA (1995c), and are shown in Table 3-19.

The resulting LADDs for carcinogenic effects and ADDs for the noncarcinogenic effects due to dermal absorption of COPCs in soil are summarized in the Risk Characterization section.

#### **3.3.4.3.14 Incidental Ingestion of Surface Soil by Child and Adult Residents.**

Exposures for incidental ingestion of chemicals in surface soil for hypothetical future child and adult residents were calculated using the equation and exposure parameters presented in Table 3-27 and discussed below.

The surface soil exposure point concentrations that were used to evaluate ingestion exposures are shown in Table 3-12. The standard default value for a soil ingestion rate (100 mg/day) recommended by USEPA (1991a) for individuals over the age of six was used for calculating potential incidental ingestion exposures for adults, while the surface soil ingestion rate of 200 mg/day (USEPA, 1991a) for children under six was used to evaluate ingestion exposures for children. The exposure frequency for both child and adult residents was assumed to be 350 days/year, a standard default USEPA (1991a) value, assuming exposures seven days/week for 50 weeks/year. The exposure duration for adults was assumed to be 30 years, which is the upper-bound value for residential tenure at one residence (USEPA, 1989b, 1991a). The exposure duration for children was assumed to be six years, based on the age period evaluated. The bioavailability factor was assumed to be 1.0.

An average body weight value of 70 kg for adults and 15 kg for children were obtained from USEPA (1991a). The USEPA (1991a) standard default of 70 years for a lifetime was used as the averaging time for carcinogenic exposures, while the duration of exposure (i.e., 30 years for adults and six years for children) was used as the averaging time for calculating the noncarcinogenic exposures.

The calculated LADDs for carcinogenic effects and ADDs for noncarcinogenic effects due to the incidental ingestion of surface soil by hypothetical future residents are summarized in the Risk Characterization section.

#### **3.3.4.3.15 Dermal Absorption of Chemicals in Surface Soil by Child and Adult Residents.**

Internal doses due to dermal absorption of chemicals in surface soil were estimated using the equation and exposure parameters discussed below and presented on Table 3-28.

The chemical concentrations in surface soil, as well as the parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used above when estimating incidental ingestion of surface soil by hypothetical future child and adult residents.

Parameters that are specific to the dermal exposure scenarios include the area of exposed skin, the amount of soil adhering to the skin, and amount of chemical absorbed through the skin from soil. For the residential scenario, it was assumed that the hands, ½ arms (i.e., forearms), ½ legs (i.e., lower legs), and feet would be exposed and available for contact with soil. Using data from USEPA (1985), and averaging across gender and age, it was estimated that the exposed skin surface area for child and adult residents would be 2,200 cm<sup>2</sup> and 6,400 cm<sup>2</sup>, respectively. The soil-to-skin adherence factor was assumed to be 1.0 mg/cm<sup>2</sup>-event, the reasonable upper-bound default value estimated by USEPA

(1992b). The dermal absorption factors from USEPA (1995b) that were used in this assessment are presented in Table 3-28.

The resulting LADDs for carcinogenic effects and ADDs for the noncarcinogenic effects due to dermal absorption of COPCs in soil are summarized in the Risk Characterization section.

### **3.3.4.3.16 Ingestion of Groundwater by Child and Adult Residents.**

Exposures for ingestion of groundwater by child and adult residents were calculated using the equation and exposure parameters presented in Table 3-29 and discussed below.

The RME exposure point concentrations to which residents could be exposed were presented earlier in Table 3-12. Drinking water ingestion rates used for residents were based on USEPA guidance. The adult ingestion rate of 2 L/day was a standard USEPA (1991a) default value, while the child 1 L/day ingestion rate was based on one-half the adult ingestion rate. Child and adult residents were conservatively assumed to consume groundwater for 350 days/year, which is an USEPA (1991a) standard default value for seven days/week, 50 weeks/year. The duration of exposure for the 1-6 year old child resident was assumed to be six years, based on the child's age duration being evaluated, while the duration of exposure for the adult resident was assumed to be 30 years, which is the USEPA (1989b, 1991a) upper-bound value for residential tenure at one residence.

The body weight value of 70 kg for an adult and 15 kg for the 1- to 6-year old child were obtained from USEPA (1991a). The USEPA (1991a) standard default of 70 years for a lifetime was used as the averaging time to calculate carcinogenic exposures, while the duration of exposure (i.e., 30 years for the adult and six years for the child) was used as the averaging time to calculate noncarcinogenic exposures.

The resulting LADDs for carcinogenic effects and ADDs for the noncarcinogenic effects for groundwater ingestion by future child and adult residents are presented later in the Risk Characterization section.

### **3.3.4.3.17 Dermal Absorption of Chemicals in Groundwater by Child and Adult Residents**

Dermal absorption of chemicals while bathing (for children) or showering (for adults) were calculated for COPCs selected in groundwater by using the equation and exposure parameters presented in Table 3-30.

The groundwater concentrations (see Table 3-12) to which residents could be exposed while bathing or showering were the same as used for the drinking water exposure pathway. Only unfiltered groundwater sample results were available, thus unfiltered inorganic concentrations were used to evaluate the dermal pathway, even though it is more likely that chemicals in the dissolved phase, rather than the total particulate phase would be absorbed through the skin. When estimating potential child and adult dermal exposures while bathing or showering, it was assumed that the entire body was available for contact with water. The surface areas that were used in the evaluation were calculated based on data provided in USEPA (1985), and were 7,000 cm<sup>2</sup> for a 1- to 6-year old and 18,000 cm<sup>2</sup> for an adult. It was also assumed that the resident takes 1 bath or shower per day (i.e., 1 event per day). In addition, exposure parameters including exposure frequency, exposure duration, body weight, and averaging time were identical to those used when evaluating the groundwater ingestion pathway.

As noted earlier, the dose absorbed per unit area per event is a function of chemical concentration in water, the permeability coefficient for that chemical from water through the skin, and exposure time. The DA value is calculated differently, depending on whether a steady-state or nonsteady-state approach is used. Following USEPA (1992b) guidance, a steady-state approach should be used to evaluate dermal absorption of inorganics from an aqueous matrix, while a nonsteady-state approach has been recommended to evaluate dermal absorption of organics in an aqueous matrix.

When calculating the absorbed dose for inorganics assuming steady-state conditions, it is assumed that the concentration gradient across all skin layers is constant and the rate that a chemical enters the skin equals the rate that it exits. Under these assumptions, DA can be estimated using the following steady-state equation from USEPA (1992b):

$$DA = C_{gw} * CF_1 * CF_2 * PC * ET$$

where:

- DA = dose absorbed per unit area per event (mg/cm<sup>2</sup>-event);
- C<sub>gw</sub> = chemical concentration in groundwater (ug/L);
- CF<sub>1</sub> = conversion factor (1 L/10<sup>3</sup> cm<sup>3</sup>);
- CF<sub>2</sub> = conversion factor (1 mg/10<sup>3</sup> ug);
- PC = chemical-specific dermal permeability coefficient (cm/hr); and
- ET = exposure time (hr/event).

The permeability coefficient is defined as a flux value, normalized for concentrations, that represents the rate at which a chemical penetrates the skin (in units of cm/hr). The default permeability coefficient for inorganics was used for all evaluated inorganics (i.e., 10<sup>-3</sup> cm/hr [USEPA, 1992b]). Permeability coefficients for all COPCs in groundwater were presented in Table 3-31. The assumed exposure time for contact with water was assumed to be 0.28 hour, the same length of time as a shower.

As noted above, USEPA (1992b) has recommended the nonsteady-state approach to estimate the dermally absorbed dose of organics from water. This approach accounts for the total amount of chemicals crossing the exposed (outside) skin surface rather than the amount that has traversed the skin and entered the blood during the exposure period (i.e., under a steady-state condition). Therefore, the nonsteady-state approach more accurately reflects normal exposure conditions and accounts for the dose that may enter the circulatory system after the exposure event due the storage of chemicals in skin lipids (USEPA, 1992b). The nonsteady-state approach has been developed for organics for which octanol-water partitioning data are available, thus was applied to the organic COPCs identified in this assessment.

The equations applied to derive DA using the nonsteady-state dermal dose model for organics were dependent on the length of assumed exposure time (ET) in relation to the time required after initial contact of a chemical with the skin for steady-state to be achieved (termed t\*). The value of t\* is dependent on chemical-specific properties, and the appropriate equation to derive t\* for a chemical is dependent on a dimensionless constant reflecting the partitioning properties of that chemical (USEPA 1992b). This constant, termed B, can be derived from the octanol-water partition coefficient (K<sub>ow</sub>) as follows:

$$B = \frac{K_{ow}}{10^4}$$

Once B has been derived, t\* can be calculated using the appropriate equation.

If  $B \leq 0.1$ , then:

$$t^* = 2.4 * \tau$$

where:

tau = lag time (hr)

If  $0.1 < B < 1.17$ , then:

$$t^* = (8.4 + 6 * \log B) * \tau$$

If  $B \geq 1.17$ , then:



$$t^* = 6 * (b - \sqrt{b^2 - c^2}) * \tau$$

where:

$$b = \frac{2}{\pi} * (1 + B)^2 - c$$

$$c = \frac{1 + 3 * B}{3}$$

The lag time ( $\tau$ ) is defined for the stratum corneum, the outermost layer of the skin, which is thought to provide the major resistance to the absorption into the circulatory system of chemicals deposited on the skin (USEPA, 1992b).  $\tau$  can be derived from the following equation:

$$\tau = \frac{l_{sc}^2}{6 * D_{sc}}$$

where:

$l_{sc}$  = thickness of stratum corneum ( $10^{-3}$  cm); and

$D_{sc}$  = diffusivity of a chemical within the stratum corneum ( $\text{cm}^2/\text{hr}$ ).

The diffusivity of a chemical within the stratum corneum ( $D_{sc}$ ) can be estimated from the thickness of the stratum corneum ( $l_{sc}$ ) and the molecular weight (MW) of the chemical using the following equation:

$$\text{Log} \frac{D_{sc}}{l_{sc}} = -2.72 - 0.0061 * MW$$

Once the time until steady-state ( $t^*$ ) has been derived, it can be compared to the assumed ET in order to select the appropriate equation to derive the dermal dose (DA). If the exposure time was less than the time until steady-state (i.e., if  $ET < t^*$ ), the following equation was used:

$$DA = 2 * C_{gw} * CF_1 * CF_2 * PC * \sqrt{\frac{6 * \tau * ET}{\pi}}$$

where:

DA = dose absorbed per unit area per event ( $\text{mg}/\text{cm}^2\text{-event}$ );

$C_{gw}$  = chemical concentration in water ( $\text{ug}/\text{L}$ );

$CF_1$  = conversion factor ( $1 \text{ L}/10^3 \text{ cm}^3$ );

$CF_2$  = conversion factor ( $1 \text{ mg}/10^3 \text{ ug}$ );

PC = chemical-specific dermal permeability coefficient ( $\text{cm}/\text{hr}$ ); and

ET = exposure time ( $\text{hr}/\text{event}$ ).

If the exposure time was greater than the time until steady-state (i.e., if  $ET > t^*$ ), then the following equation was used:

$$DA = C_{gw} * CF_1 * CF_2 * PC * \left[ \frac{ET}{1+B} + 2 * \tau * \frac{1+3*B}{1+B} \right]$$

Estimated permeability coefficients (PC) provided in USEPA (1992b) were used for the organic COPCs. If estimated permeability coefficients were not available for organics, permeability coefficients were estimated by USEPA (1992b) using the following equation:

$$\log(PC) = -2.72 + (0.71 * \log K_{ow}) - (0.0061 * MW)$$

All inputs to equations presented above, including permeability coefficients,  $\log K_{ow}$ s, and molecular weights that were needed to calculate the  $DA_{event}$  for all COPCs in groundwater are presented in Table 3-31.

The resulting  $LADDs_{int}$  for the carcinogenic effects and the  $ADDs_{int}$  for noncarcinogenic effects of a child's and adult's dermal absorption of chemicals while bathing are summarized in the Risk Characterization section.

#### 3.3.4.3.18 Ingestion of Groundwater by Workers

Exposures for ingestion of groundwater by workers were calculated using the equation and exposure parameters presented in Table 3-32 and discussed below.

The RME exposure point concentrations to which workers could be exposed were presented earlier in Table 3-12. The worker ingestion rate of 1 L/day was obtained from USEPA (1991a). Workers were assumed to consume groundwater for 250 days/year, which is an USEPA (1991a) standard default value for working five days/week, 50 weeks/year. The duration of exposure for the worker was assumed to be 25 years, which is the USEPA (1991a) upper-bound value for time spent working at one job.

The body weight value of 70 kg for an adult was obtained from USEPA (1991a). The USEPA (1991a) standard default of 70 years for a lifetime was used as the averaging time to calculate carcinogenic exposures, while the duration of exposure (i.e., 25 years) was used as the averaging time to calculate noncarcinogenic exposures.

The resulting LADDs for carcinogenic effects and ADDs for the noncarcinogenic effects for groundwater ingestion by future workers are presented later in the Risk Characterization section.

### 3.4 TOXICITY ASSESSMENT

The general methodology for the classification of health effects and the development of health effects criteria is described in Section 3.4.1. This provides the analytical framework for the characterization of human health risks. In Section 3.4.2, the health effects criteria used to derive estimates of risk are presented. These values are combined with dose information for each pathway quantitatively evaluated to predict potential risks associated with exposures to COPCs.

The methodology used for classifying health effects from exposure to chemicals is recommended by USEPA guidance (1986a,b, 1989a, 1995d, 1996). Chronic toxicity criteria were obtained from USEPA's Integrated Risk Information System (IRIS) (USEPA, 1996) and Health Effects Assessment Summary Tables (HEAST) (USEPA, 1995d). These sources list the most recent toxicity values recommended by USEPA for use in HHRAs.

#### 3.4.1 Health Effects Classification and Criteria Development

Separate health criteria are developed for chemicals depending on whether exposure to them may be associated with principally carcinogenic (cancer-causing) or noncarcinogenic effects, or both. This distinction relates to the currently held scientific opinion that the mechanism of action for each

category is different. For assessing risks associated with potential carcinogens, USEPA has adopted the scientific policy position that a small number of molecular events can evoke changes in a single cell, or a small number of cells, that can lead to tumor formation. This is described as a no-threshold initiator mechanism, because it is assumed that there is essentially no level of exposure (i.e., a threshold) to a carcinogen that will not result in some finite possibility of causing cancer. Another assumption stemming from USEPA's science policy is that the dose-response curve is linear at low doses. In reality, this curve can take many shapes depending on the exact biological mechanisms of action of a chemical. The dose-response curve will especially vary if the chemical is behaving as a cancer promotor rather than as an initiator, with the net effect that the most accurate shape may be indicative of a threshold for response.

In the case of chemicals exhibiting noncarcinogenic effects, however, it is believed that organisms have repair and detoxification capabilities that must be exceeded by some critical concentration (threshold) before the adverse effect is manifested. For example, an organ can have a large number of cells performing the same or similar functions that must be significantly depleted before the effect on the organ is realized. This threshold view holds that a range of exposures from just above zero to some finite value can be tolerated by the organism without an appreciable risk of adverse effects.

#### **3.4.1.1 Health Effects Criteria for Potential Carcinogens**

For carcinogens, USEPA's Carcinogen Risk Assessment Verification Endeavor (CRAVE) evaluates the excess lifetime cancer risks associated with various levels of exposure by developing cancer slope factors and unit risks. Cancer slope factors are expressed in terms of reciprocal dose, as units of  $(\text{mg chemical/kg body weight-day})^{-1}$ . They describe the upper-bound increase in an individual's risk of developing cancer over a 70-year lifetime per unit of exposure. Unit risks are expressed either as a reciprocal air concentration in units of  $(\mu\text{g/L})^{-1}$ , or as a reciprocal drinking water concentration, in units of  $(\mu\text{g/L})^{-1}$ . Similarly, they are defined as the probability of an individual developing cancer over a 70-year lifetime as a result of exposure to one unit of concentration in air or water. Because regulatory efforts are geared to be protective of public health, including even the most sensitive members of the population, the cancer slope factors are derived using conservative assumptions.

Cancer slope factors and unit risks are derived from the results of human epidemiological studies or chronic animal bioassays. The animal studies usually must be conducted using relatively high doses to detect possible adverse effects. Because humans are expected to be exposed to doses lower than those used in the animal studies, the potential cancer risks at lower doses are estimated by using mathematical models. The data from animal studies are typically fitted to the linearized multistage model to obtain a dose-response relationship. In general, after the data are fit to the dose-response model, the 95 percent upper confidence limit of the slope of the resulting dose-response relationship at low doses is calculated. This upper-bound limit is subjected to various adjustments, and an interspecies scaling factor is applied to derive the slope factor or unit risk for humans. Thus, the actual risks associated with a given intake of a potential carcinogen quantitatively evaluated based on animal data are generally regarded as not likely to exceed the risks estimated using these slope factors and unit risks, and they may be as low as zero (USEPA 1986a). Dose-response data derived from human epidemiological studies are fitted to dose-time-response curves. These models provide rough, but plausible, estimates of the upper limits on lifetime risk. Slope factors and unit risks based on human epidemiological data are derived using conservative assumptions and, as such, they too are unlikely to underestimate risks for a given level of exposure.

USEPA assigns weight-of-evidence classifications to potential carcinogens. Under this system, chemicals are classified as either Group A, Group B1, Group B2, Group C, Group D, or Group E. These categories represent an assessment of the amount and quality of the data that support the finding that specific chemicals and elements can cause cancer in humans. Group A includes those substances for which high-quality studies have demonstrated a relationship between the exposure to the substance in question and the development of cancer in human populations. Groups B1, B2 and C represent chemicals with limited (B1) or insufficient (B2) human evidence of carcinogenicity; and sufficient (B1, B2) or insufficient (C) animal data. Group D substances are those for which there is insufficient or no evidence of carcinogenicity in humans or animals, while Group E substances are those for which no evidence of carcinogenicity is available in adequate human or animal studies.

### 3.4.1.2 Health Effects Criteria for Noncarcinogens

Oral health criteria for chemicals exhibiting noncarcinogenic effects are generally developed using verified reference doses (RfDs). These are developed by USEPA's RfD Work Group and listed in IRIS (USEPA, 1996), or can be obtained from HEAST (USEPA, 1995d) and supplements. The RfD is expressed in units of dose (mg chemical/kg body weight-day), and is usually derived either from human studies involving work-place exposures or from animal studies. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population (including sensitive subpopulations) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The RfD is used as a reference point for gauging the potential effects of exposures. Usually, exposures (as chemical intakes or doses) that are less than the RfD are not likely to be associated with adverse health effects. As the frequency and/or magnitude of the exposures exceeding the RfD increase, the probability of adverse effects in a human population increases.

RfDs are developed for both chronic and subchronic exposures. Chronic RfDs are presented in IRIS or HEAST and are intended for use in evaluating exposures of durations greater than seven years. Subchronic RfDs are developed by USEPA's National Center for Environmental Assessment (NCEA, formerly called the Environmental Criteria and Assessment Office [ECAO]) and are used to characterize the potential for the occurrence of noncarcinogenic effects associated with short-term exposures (two weeks to seven years as defined by USEPA [1989a]). The subchronic RfDs are developed similarly to chronic RfDs, and are typically equal to chronic RfDs or are one order of magnitude greater (less stringent). The subchronic RfDs are presented in HEAST, but they are not peer reviewed.

The RfDs are derived using uncertainty factors that reflect scientific judgment regarding the various types of data used to estimate the RfD. RfDs are typically estimated from no-observable-adverse-effect-levels (NOAELs) or lowest-observable-adverse-effect-levels (LOAELs) in human or animal studies. Uncertainty factors, generally 10-fold factors, are intended to account for:

- the variation in sensitivity among members of the human population;
- the uncertainty in extrapolating animal data to the case of humans;
- the uncertainty in extrapolating from data obtained in a study that is less-than-lifetime exposure;
- the uncertainty in using LOAEL data, when necessary, rather than NOAEL data; and
- the inability of any single study to adequately address all possible adverse outcomes in humans.

To derive RfDs, NOAELs or LOAELs are divided by one or more uncertainty factors, as appropriate. When taken together, these uncertainty factors may confer an extra margin of safety of up to a factor of 10,000 below a LOAEL. In some cases, modifying factors are also applied to RfDs to take into account other uncertainties in the toxicity database and reflect the professional judgment of those reviewing the database. The net result is that RfDs are generally considered to provide a conservative estimate of the likelihood of adverse noncarcinogenic effects.

### 3.4.2 Health Criteria for Individual Chemicals of Potential Concern

Table 3-33 presents the oral human health effects criteria used to quantitatively evaluate potential health effects of human exposures to COPCs at OU3. Consistent with USEPA (1989a), subchronic toxicity criteria should be used to evaluate substantially less-than-lifetime exposures. As a result, chronic toxicity criteria were used to evaluate exposure pathways for all receptors except construction/excavation workers. Because construction/excavation workers at the ditches would be expected to work at OU3 for no more than one year, subchronic toxicity criteria were used for this receptor. Subchronic RfDs for all chemicals for this pathway were the same as the chronic RfDs, and are thus not presented separately.

Mercury was selected as a COPCs in fish, and because the most likely form of mercury in fish tissue would be in the methylated form, the toxicity criterion for methyl mercury was used to assess potential effects associated with ingestion of mercury in fish.

USEPA-approved oral health effects criteria were not available for delta-BHC, which was identified as a COPCs in fish. Oral toxicity criteria exist for other BHC congeners (e.g., alpha-, beta- and gamma-BHC), although none has the same Class D weight-of-classification as delta-BHC (i.e., the other BHC congeners are Class B2 or C carcinogens). Therefore, no other BHC congener was used as a surrogate to evaluate potential ingestion risks. The uncertainties associated with not evaluating delta-BHC are discussed in the Uncertainty Section.

Toxicity criteria have not been developed by USEPA specifically for the dermal route of exposure; instead, oral health effects criteria are adjusted to assess this pathway. In order to have a meaningful comparison between the dermal dose estimates, which represent internal (or absorbed) doses, and toxicity criteria, which typically represent potential (or administered) doses, toxicity criteria should be modified to represent absorbed doses. (In cases where the toxicity criteria are based on internal doses, this modification is not required.) The method for modifying toxicity criteria involves determination of an absolute oral absorption factor for each chemical and use of this value to increase the chemical's cancer slope factor or decrease the chemical's RfD. Cancer slope factors and RfDs adjusted in this manner are then more appropriate to assess absorbed dose-response, rather than administered dose-response. The absolute oral absorption factors that are applied should reflect the specific conditions under which the toxicological study was conducted (e.g., method of administration such as gavage, water or diet, and vehicle of administration such as solvent or solution). Table 3-34 presents the absolute oral absorption factors used to adjust the oral toxicity criteria for the chemicals of concern when evaluating dermal absorption of chemicals, as well as the actual adjusted toxicity criteria. For most chemicals, absolute oral absorption factors were obtained from the Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profile documents. For those chemicals for which sufficient information is lacking, a default absolute oral absorption factor of one (1.0) was used (i.e., oral toxicity criteria were not changed).

### 3.5 RISK CHARACTERIZATION

This section of the HHRA evaluates the potential human health effects associated with exposures to chemicals in sediment, surface water, and fish at OU3. To quantitatively assess risks associated with exposures to chemicals at the site, the health effects criteria (slope factors/RfDs) presented in the toxicity assessment (Section 3.4) were combined with the average daily doses ([L]ADDs) derived in the exposure assessment (Section 3.3).

For oral exposures to potential carcinogens, excess lifetime cancer risks were obtained by multiplying the estimated LADDs for each chemical by its upper-bound cancer slope factor. The total upper-bound excess lifetime cancer risk for each pathway was obtained by summing the chemical-specific risk estimates. This approach is consistent with USEPA's guidelines for evaluating the toxic effects of chemical mixtures (USEPA, 1989a). Using this approach, a risk level of  $1 \times 10^{-6}$ , for example, represents an upper-bound probability of one in one million that an individual could contract cancer due to exposure to the potential carcinogen under the specified exposure conditions.

The approach of calculating carcinogenic risks by multiplying the LADD by the slope factor assumes that the increased risk of cancer resulting from exposure to a constituent is linearly proportional to the amount of chemical intake averaged over a lifetime. According to USEPA (1989a) HHRA guidance, this approach is only appropriate when the estimated carcinogenic risks calculated are less than  $10^{-2}$  (i.e., one excess cancer case per 100 people exposed). If the estimated risks are above  $10^{-2}$ , the assumption of linearity is not valid. In such cases, the carcinogenic risks should be calculated using the following equation, per USEPA HHRA guidance (USEPA, 1989a).

$$Risk = 1 - e^{(-LADD * CSF)}$$

For those chemicals resulting in risks greater than  $1 \times 10^{-2}$ , the potential carcinogenic risks were estimated by summing the chemical-specific risks to yield exposure pathways risks. Implicit in this approach is the assumption that potential carcinogenic risks from multiple chemical exposures are additive such that the total pathway-specific risk is equal to the sum of the individual chemical-specific

risks. Similarly, the excess lifetime cancer risks for each carcinogenic compound were also summed for each exposure pathway. The resulting total chemical-specific risks represent the upper-bound potential risk of developing cancer from that chemical upon exposure to that medium (i.e., the risk may be lower, but is unlikely to be greater).

The upper-bound lifetime excess cancer risks derived in this report can be compared to USEPA's risk range for health protectiveness at Superfund sites of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  (USEPA, 1990b). In addition, USEPA's Office of Solid Waste and Emergency Response (USEPA, 1991b) has issued a directive clarifying the role of the HHRA in the Superfund process. The directive states that where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for current or future land-use for all media combined is less than  $1 \times 10^{-4}$ , and the non-carcinogenic hazard quotient is less than one, action generally is not warranted unless there could be adverse environmental effects.

Potential adverse effects associated with oral and dermal exposures to noncarcinogens are presented as the ratio of the ADD to the reference dose (ADD:RfD). Values of these ratios, called hazard quotients, that are greater than one are indicative of a potential for adverse health effects. The additive effect for each noncarcinogen is assumed, and the sum of the hazard quotients for all the individual COPCs in a given pathway is termed the hazard index. The hazard index is useful as a reference point for gauging the potential effects of environmental exposures to complex mixtures. Hazard indices that are less than 1.0 should be viewed as indicating, with a high level of assurance, but not complete certainty, that adverse effects would not be associated with the exposures being evaluated. Hazard indices exceeding 1.0 indicate the potential for the occurrence of adverse effects. A decision should not be categorically drawn that hazard indices less than one are acceptable (or risk-free) or that hazard indices greater than one are unacceptable (or will result in adverse effects). This is a consequence of the great uncertainty inherent in estimates of the ADD:RfD ratio, in addition to the fact that there are uncertainties associated with assuming the individual hazard quotients in the hazard index calculation are additive.

In cases where the calculated hazard index exceeds one, the COPCs are subdivided into categories based on target organ or critical effect (e.g., liver, kidney, etc.), in accordance with USEPA guidance (USEPA, 1989a). Hazard indices are then recalculated for these categories to identify the potential for noncarcinogenic effects to occur with respect to any given endpoint. Organ-specific hazard indices exceeding 1.0 indicate the potential for the occurrence of adverse effects. They do not, however, provide a numerical estimate of either the probability or severity of the adverse effect.

The following sections present the predicted risks and hazard indices associated with each exposure pathway evaluated in the HHRA. Sections 3.5.1 and 3.5.2 present the estimated risks for individual pathways for the current and future exposure scenarios, respectively. Section 3.5.3 presents the cumulative risk estimates for all exposure pathways evaluated under both current and future land-use conditions.

### **3.5.1 Potential Risks Under Current Land-Use Conditions**

#### **3.5.1.1 Sediment**

As shown in Tables 3-35 and 3-36, excess lifetime cancer risks associated with trespasser/recreational user ingestion and dermal exposures to chemicals in sediment from the PCBs Area were  $7 \times 10^{-7}$  and  $2 \times 10^{-6}$ , respectively, both due to PCB-1260 exposures. Because none of the COPCs at the PCBs Area had RfDs, hazard indices were not calculated. Excess lifetime cancer risks associated with ingestion and dermal exposures to chemicals in sediment from the Pesticides Area were  $3 \times 10^{-8}$  and  $2 \times 10^{-7}$ , respectively. Once again, because none of the COPCs at the Pesticides Area had RfDs, hazard indices were not calculated.

#### **3.5.1.2 Surface Water**

As shown in Table 3-37, the hazard index associated with trespasser/recreational user dermal exposures to chemicals in surface water from both the PCBs and Pesticides Areas were much lower than one, indicating that noncarcinogenic adverse effects would not likely occur. Because no carcinogenic chemicals were selected as COPCs for either area, excess lifetime cancer risks were not calculated.

### 3.5.1.3 Surface Soil

As shown in Tables 3-38 and 3-39, excess lifetime cancer risks associated with trespasser/recreational user ingestion and dermal exposures to chemicals in soil from the PCBs Area were  $3 \times 10^{-6}$  and  $2 \times 10^{-5}$ , respectively, both due to exposures to benzo(a)pyrene. Because none of the COPCs had RfDs, hazard indices were not calculated.

## 3.5.2 Potential Risks Under Future Land-Use Conditions

### 3.5.2.1 Sediment

As shown in Tables 3-40 and 3-41, excess lifetime cancer risks associated with a child's ingestion and dermal exposures to chemicals in sediment from the PCBs Area were  $5 \times 10^{-6}$  and  $4 \times 10^{-6}$ , both due to PCB-1260. Because none of the COPCs had RfDs, hazard indices were not calculated. Excess lifetime cancer risks associated with ingestion and dermal exposures to chemicals in sediment from the Pesticides Area were  $2 \times 10^{-7}$  and  $3 \times 10^{-7}$ , respectively. Once again, because none of the COPCs had RfDs, hazard indices were not calculated.

As shown in Tables 3-42 and 3-43, excess lifetime cancer risks associated with worker ingestion and dermal exposures to chemicals in sediment from the PCBs Area were  $2 \times 10^{-7}$  and  $1 \times 10^{-7}$ . Because no noncarcinogenic chemicals were selected as COPCs, hazard indices were not calculated for the PCBs Area. Excess lifetime cancer risks associated with ingestion and dermal exposures to chemicals in sediment from the Pesticides Area were  $1 \times 10^{-8}$  and  $8 \times 10^{-9}$ , respectively. Once again, because no noncarcinogenic chemicals were selected as COPCs, hazard indices were not calculated.

As shown in Tables 3-44 and 3-45, excess lifetime cancer risks associated with an environmental educator's ingestion and dermal exposures to chemicals in sediment from the PCBs Area were  $6 \times 10^{-6}$  and  $1 \times 10^{-5}$ . Because no noncarcinogenic chemicals were selected as COPCs, hazard indices were not calculated for the PCBs Area. Excess lifetime cancer risks associated with ingestion and dermal exposures to chemicals in sediment from the Pesticides Area were  $3 \times 10^{-7}$  and  $1 \times 10^{-6}$ , respectively. Once again, because no noncarcinogenic chemicals were selected as COPCs, hazard indices were not calculated.

### 3.5.2.2 Surface Water

As shown in Table 3-46, the hazard indices associated with a child's dermal exposures to chemicals in surface water from both the PCBs and Pesticides Areas were much lower than one, indicating that noncarcinogenic adverse effects would not likely occur. Because no carcinogenic chemicals were selected as COPCs for either area, excess lifetime cancer risks were not calculated.

As shown in Table 3-47, the hazard indices associated with an environmental educator's dermal exposures to chemicals in surface water from both the PCBs and Pesticides Areas were much lower than one, indicating that noncarcinogenic adverse effects would not likely occur. Because no carcinogenic chemicals were selected as COPCs for either area, excess lifetime cancer risks were not calculated.

### 3.5.2.3 Fish

As shown in Table 3-48, under future land-use conditions, excess lifetime cancer risks associated with ingestion of fish ranged from  $5 \times 10^{-3}$  for eel to  $2 \times 10^{-5}$  for white perch. Without exception, the greatest risks for all fish species were due to PCB-1260 in fish tissue. Hazard indices for all species were less than one, indicating that ingestion of fish would not result in adverse effects due to noncarcinogenic compounds.

### 3.5.2.4 Groundwater

As shown in Tables 3-49 and 3-50, excess lifetime cancer risks associated with child and adult ingestion and dermal absorption of COPCs in groundwater were all below the  $1 \times 10^{-6}$  level. Hazard indices for ingestion of groundwater were above one, due to iron (for which no target organ exists) and manganese (affecting the CNS), indicating that adverse effects could occur to the CNS for both child and adult residents. Hazard indices associated with the dermal pathway were below one.

As shown in Table 3-51, the excess lifetime cancer risk associated with worker ingestion of COPCs in groundwater was  $2 \times 10^{-7}$ , while the hazard index was below one, indicating noncarcinogenic effects would not likely occur.

### 3.5.2.5 Surface Soil

As shown in Tables 3-52 and 3-53, excess lifetime cancer risks associated with child ingestion and dermal exposures to chemicals in soil from the PCBs Area were  $9 \times 10^{-5}$ . Risks for adults were  $5 \times 10^{-5}$  and  $2 \times 10^{-4}$ , respectively, both due to exposures to benzo(a)pyrene. Because none of the COPCs had RfDs, hazard indices were not calculated.

As shown in Tables 3-54 and 3-55, excess lifetime cancer risks associated with worker ingestion and dermal exposures to chemicals in soil from the PCBs Area were  $1 \times 10^{-5}$  and  $1 \times 10^{-4}$ , respectively, both due to exposures to benzo(a)pyrene. Because none of the COPCs had RfDs, hazard indices were not calculated.

As shown in Tables 3-56 and 3-57, excess lifetime cancer risks associated with an environmental educator's ingestion and dermal exposures to chemicals in soil from the PCBs Area were  $3 \times 10^{-5}$  and  $1 \times 10^{-4}$ , respectively, both due to exposures to benzo(a)pyrene. Because none of the COPCs had RfDs, hazard indices were not calculated.

### 3.5.3 Cumulative Risks

Individuals may be exposed at one time by a combination of pathways, and therefore, the combined pathway risks for plausible multiple pathway exposures were calculated. Cumulative risk estimates calculated for trespassers/recreational users under current land-use conditions are first presented, and are followed by cumulative risk estimates for workers, environmental educators, and child and adult residents under future land-use conditions.

#### 3.5.3.1 Current Land-Use Conditions

The summary of cumulative risks for trespassers/recreational users under current land-use conditions are presented in Table 3-58. Cumulative risks for exposures to the PCBs Areas and Pesticides Areas were calculated separately.

As shown in Table 3-58, the cumulative risks for trespassers/recreational users was  $3 \times 10^{-5}$  for the PCBs Area and  $2 \times 10^{-7}$  at the Pesticides Area, which are either lower than or in the mid range of the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range for health protectiveness at Superfund sites. The cumulative hazard index was below one at both areas, indicating that adverse noncarcinogenic effects would not be likely to occur, based on exposures through all pathways.

#### 3.5.3.2 Future Land-Use Conditions

Summaries of cumulative risks for hypothetical future workers, environmental educators, and child and adult residents are also presented in Table 3-58. Once again, cumulative risks were calculated separately for both the PCBs and the Pesticides Areas.

As shown in Table 3-58, the cumulative risk for workers was  $1 \times 10^{-4}$  for the PCBs Area and  $2 \times 10^{-8}$  for the Pesticides Area, either lower than or at the high end of the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range.

The cumulative risk for future environmental educators was  $1 \times 10^{-4}$  for the PCBs Area and  $1 \times 10^{-6}$  for the Pesticides Area, either at the low or high end of the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range for health protectiveness at Superfund sites. The cumulative hazard index was below one at both areas, indicating that adverse noncarcinogenic effects would not be likely to occur, based on exposures through all pathways.

The cumulative risk for child residents was  $2 \times 10^{-4}$  for the PCBs Area and  $5 \times 10^{-7}$  for the Pesticides Area, either lower than or just above the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range, as shown in Table 3-58. The cumulative hazard index was above one (5) for the PCBs Area, while the cumulative hazard index was below one for the Pesticides Area.



The cumulative risk for adult residents was  $5 \times 10^{-3}$ , above the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range, as shown in Table 3-58. The cumulative hazard index for adults was above one (2).

### 3.6 UNCERTAINTY ANALYSIS

There is a large degree of uncertainty associated with the estimates of human health risks in any HHRA. Consequently, the estimates calculated for OU3 should not be construed as absolute estimates of risk but rather as conditional estimates based on a number of assumptions regarding exposure and toxicity. In general, the primary sources of uncertainty are associated with environmental sampling and analysis; selection of chemicals for evaluation; exposure assessment; and toxicological data.

A thorough understanding of the uncertainties associated with the risk estimates is critical to understanding the true nature of the estimated risks and to placing the estimated risks in proper perspective. Some of the more important sources of uncertainty associated with the estimations of risk at OU3 are summarized below.

#### 3.6.1 Environmental Sampling and Analysis

Uncertainty in environmental chemical analysis can stem from several sources including errors inherent in the sampling or analytical methods. Analytical precision or accuracy errors can be the source of a great deal of uncertainty. There is uncertainty associated with chemicals reported in samples at concentrations below the reported detection limit, but still included in data analysis, and with those chemicals qualified with the letter J, indicating that the concentrations are estimated. The effects of using data with these uncertainties may over- or under-estimate risks.

As noted earlier, surface water sampling occurred during or after storm events, so it is possible that inorganics surface water concentrations were higher than they would have been if no storm events had occurred prior to sampling. The elevated suspended solids concentrations likely resulted in retaining several inorganic COPCs for evaluation, whereas they may not have been selected if suspended sediment concentrations would have been lower.

#### 3.6.2 Selection of Chemicals for Evaluation

A comparison of maximum detected chemical concentrations to USEPA Region III RBCs was conducted for each medium. Chemicals whose maximum concentrations were below their respective RBCs were not carried through the assessment. It is unlikely that this risk-based screening would have excluded chemicals that would be of concern, based on the conservative exposure assumptions and conservatively derived toxicity criteria that are the basis of the RBCs. Although following this methodology does not provide a quantitative risk estimate for all chemicals, it focuses the assessment on the chemicals accounting for the greatest risks (i.e., chemicals whose maximum concentrations exceeded their respective RBCs), and the overall cumulative risk estimates would not be expected to be significantly (if at all) greater.

There is uncertainty associated with eliminating inorganic chemicals from evaluation based on comparisons of site and background data. Although five samples were available in the background data set for both sediment and surface water, there nevertheless exists some uncertainty associated with the inorganic chemical selection process if the background samples do not adequately characterize true background concentrations. Therefore, in accordance with USEPA Region III policy, an evaluation was conducted for chemicals that were determined to be within background concentrations, but that exceeded their respective RBCs. Risk estimates for all chemicals that were classified as "b" (within background levels but above respective RBCs) in the data summary tables were calculated. Risks for all chemicals and pathways were typically below or in the low-to-mid range of the USEPA target risk range of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$ ; all hazard indices were less than one, indicating that noncarcinogenic effects are not likely. Consequently, eliminating chemicals as COPCs that were within background concentrations and greater than RBCs did not significantly alter the conclusions concerning risks associated with exposures to site-related inorganic concentrations.

#### 3.6.3 Exposure Assessment

There are several sources of uncertainty in the exposure assessment, including the determination of the exposure point concentrations, the selection of input parameters used to estimate

chemical intakes ([L]ADDs), and other assumptions used in the exposure models. The uncertainties associated with these various sources are discussed below.

Only unfiltered (i.e., total) surface water exposure point concentrations were available for evaluating dermal absorption of chemicals in surface water, even though chemicals in the dissolved phase would more readily be dermally absorbed than chemicals in the particulate phase. However, because only unfiltered concentrations were available, they were conservatively used to evaluate this pathway, therefore, most likely overestimating potential exposures to COPCs in surface water.

When calculating exposure point concentrations in sediment from sampling data,  $\frac{1}{2}$  of the reported detection limit was used for non-detected concentrations in the calculation of the 95% UCL. Any approach dealing with non-detected chemical concentrations is associated with some uncertainty. This is because chemicals that were not detected at the specified detection limit may be absent from the medium or may be present at any concentration below the detection limit. This uncertainty will err on the side of overestimation of exposure point concentrations as the number of non-detects in a data set increases.

The 95% UCL was used preferably as the exposure point concentration for each medium. If the 95% UCL exceeded the maximum detected value, the maximum was conservatively used as a default for the exposure point concentration. Using a value that is based on one sampling location (i.e., the maximum) is associated with some uncertainty, and adds a great deal of conservatism to the assessment. Maximum detected values were used as exposure point concentrations for all organic COPCs in sediment from the PCBs and Pesticides Areas, three of the six inorganics selected as COPCs in surface water from two areas, and over half of the COPCs selected from groundwater and surface soil. A large number of exposure point concentrations of COPCs in fish also were the maximum detected concentrations.

With respect to determining exposure point concentrations, it was assumed that the concentrations of chemicals in the media evaluated would remain constant over time. Depending on the properties of the chemicals and the media in which they were detected, this assumption could overestimate risks to a low or high degree, since it is possible that chemicals could degrade or be transported to other media. It should be noted that the sources of PCBs (i.e., the washrack and the oil/water separator) have been removed. Therefore, concentrations of PCBs in sediment will not increase over time, but will likely decrease.

An underlying assumption of the HHRA is that individuals in the site would engage in certain activities that would result in exposures via each selected pathway. However, it should be noted that even if an individual engaged in an activity, it is not necessarily true that an exposure would be experienced. For example, it is unlikely that every time a trespasser comes on the site, he or she would contact and incidentally ingest and be dermally exposed sediment. More unlikely, however, are the assumptions that residential development would occur at OU3, especially in light of the transfer of the property to the USFWS. Further, making the assumption that hypothetical future residents would consume fish (especially eel) from the ditches at OU3 is also considered to be extremely unlikely. If individuals were to reside in the vicinity of OU3, they would more likely catch and eat fish from Occoquan Bay than from the ditches. Further, the fish ingestion rate that was used to evaluate adult ingestion of fish was based on recreational fishing and is equivalent to about one 8-ounce servings per week (USEPA, 1991a), much higher than any likely fish ingestion scenario that would occur at OU3.

The parameter values used to describe the extent, frequency, and duration of exposure are associated with some uncertainty. Actual risks for certain individuals within an exposed population may vary from those predicted depending upon their actual intake rates (e.g., sediment ingestion rates), nutritional status, or body weights. The exposure assumptions were selected to produce an upper-bound estimate of exposure in accordance with USEPA guidelines regarding evaluation of potential exposures at Superfund sites (e.g., exposures were assumed to occur for 30 years for adult residents). In addition, many USEPA (1989a) default exposure parameters are highly conservative and are based on risk management interpretations of limited data. An example is soil ingestion rates, which were used to evaluate sediment ingestion exposures. Although current USEPA guidance recommends default soil ingestion rates of 100 mg/day for those over six years of age, other studies, such as Calabrese et al. (1990), have shown that the USEPA default soil ingestion rate of 100 mg/day is likely to greatly

overestimate exposures and risks. In addition, all chemicals in sediment were assumed to be 100% bioavailable; this assumes that all ingested chemicals present in a sediment matrix are absorbed through the gastrointestinal tract, which is unlikely due to their affinity to the sediment particles. Therefore, based on the conservative exposure assumptions used in the HHRA, exposures and estimated potential risks are likely to be overestimated for the exposure pathways.

Evaluation of the dermal exposure pathway is affected by uncertainties in exposure parameters specific to dermal contact. For example, there is uncertainty associated with the exposed skin surface areas used, since the choice of exposed body parts could slightly over- or underestimate risks. More significant uncertainties are associated with the selection and use of dermal absorption fractions. Very limited information is available on dermal absorption of chemicals from contacted sediment under realistic environmental conditions. In fact, there are no actual human epidemiological data to support the hypothesis that absorption of sediment-bound compounds under realistic exposure conditions is a complete route of exposure. Therefore, evaluation of dermal absorption of COPCs from sediment may result in an overestimation of risks.

### 3.6.4 Toxicological Data

In most HHRAs, one of the largest sources of uncertainty is health criteria values. The health criteria used to evaluate long-term exposures, such as reference doses or cancer slope factors, are based on concepts and assumptions that bias an evaluation in the direction of over-estimation of health risk. As USEPA notes in its Guidelines for Carcinogenic RA (USEPA, 1986a):

"There are major uncertainties in extrapolating both from animals to humans and from high to low doses. There are important species differences in uptake, metabolism, and organ distribution of carcinogens, as well as species and strain differences in target site susceptibility. Human populations are variable with respect to genetic constitution, diet, occupational and home environment, activity patterns, and other cultural factors."

These uncertainties are compensated for by using upper-bound 95% UCLs or maximum likelihood estimates for cancer slope factors for carcinogens, and safety factors for reference doses for noncarcinogens. The assumptions provide a rough but plausible estimate of the upper limit of risk.

For dermal exposure pathways, the absence of dermal toxicity criteria necessitated the use of oral toxicity data. To calculate risk estimates for the dermal pathway, therefore, absorbed dermal doses were combined with oral toxicity values. As described in Section 3.4, oral toxicity values, which are typically expressed in terms of potential (or administered) doses, should be adjusted when assessing dermal doses, which are expressed as internal (or absorbed) doses. In this assessment, absolute oral absorption factors that reflect the toxicity study conditions were used to modify the oral toxicity criteria. For those chemicals for which sufficient information is lacking, a default oral absorption factor of 100% (1.0) was used. The risk estimates for the dermal pathways may be under-estimated depending on how closely these values reflect the difference between the oral and dermal routes. It should be noted that the risks associated with dermal exposure to beryllium are especially affected by the very low absolute oral absorption factor (i.e., 0.5%). Considering that beryllium is assumed to be absorbed more efficiently through the skin (1%) than in the gastrointestinal system (0.5%), considerable uncertainty appears to be associated with the absorption efficiency of beryllium.

Delta-BHC could not be quantitatively evaluated because no toxicity criteria exist for this compound. Although oral toxicity criteria exist for other BHC congeners (e.g., alpha-, beta- and gamma-BHC), although none has the same Class D weight-of-classification as delta-BHC (i.e., the other BHC congeners are Class B2 and C carcinogens). Therefore, no other BHC congener was used as a surrogate to evaluate potential ingestion risks. Although not quantifying risks for delta-BHC could underestimate fish ingestion risks, risks would not likely be significantly underestimated, because chemicals that drove risks for the fish ingestion pathway were detected at much greater concentrations.

### 3.7 SUMMARY AND CONCLUSIONS

This HHRA was performed to evaluate the potential human health effects associated with chemical contamination at OU3. The first task of the HHRA was to summarize chemicals found in

sediment, surface water, fish, groundwater, surface soil, and subsurface soil at OU3. The data from sediment and surface water were then separated into groupings, according to areas of contamination.

After the data were summarized, maximum concentrations of detected chemicals were compared to USEPA Region III RBCs. If the chemical concentrations exceeded the RBCs, they were retained as COPCs. The next step in the screening process was to statistically compare on-site and background chemical concentrations for inorganic chemicals that were not screened out in the RBC screening. If inorganic chemical concentrations were within background levels, they were not considered to be COPCs. Risks for these inorganic chemicals present at concentrations greater than RBCs but within background levels also were evaluated, although separately from site-related COPCs. Chemicals that were not eliminated as a result of both the RBC and background screening procedures were considered to be COPCs, and were retained for detailed evaluation in the HHRA.

For each COPC, quantitative oral toxicity criteria were compiled. The toxicity criteria were obtained primarily from USEPA's IRIS and HEAST.

Potential exposure pathways were reviewed, and the following complete exposure pathways were evaluated for current land-use conditions:

- Incidental ingestion and dermal absorption of COPCs in sediment by a trespasser/recreational user;
- Dermal absorption of COPCs in surface water by a trespasser/recreational user; and
- Incidental ingestion and dermal absorption of COPCs in surface soil by a trespasser/recreational user.

Although the likelihood of future residential exposures is highly unlikely, since the facility will be transferred to the USFWS, under future land-use conditions, the following complete exposure pathways were quantitatively evaluated:

- Incidental ingestion and dermal absorption of COPCs in sediment by child residents;
- Dermal absorption of COPCs in surface water by child residents;
- Incidental ingestion and dermal absorption of COPCs in sediment by workers;
- Incidental ingestion and dermal absorption of COPCs in sediment by environmental educators;
- Dermal absorption of COPCs in surface water by environmental educators;
- Ingestion of fish by adult residents;
- Incidental ingestion and dermal absorption of COPCs in surface soil by child residents;
- Incidental ingestion and dermal absorption of COPCs in surface soil by adult residents;
- Incidental ingestion and dermal absorption of COPCs in surface soil by workers;
- Incidental ingestion and dermal absorption of COPCs in surface soil by environmental educators;
- Ingestion and dermal absorption of COPCs in groundwater by child residents;
- Ingestion and dermal absorption of COPCs groundwater by adult residents; and
- Ingestion of COPCs in groundwater by workers.

An RME case was evaluated in this HHRA, in order to place a conservative upper-bound on the potential risks, meaning that the risk estimates were unlikely to be underestimated but may very well have been overestimated. ADDs for noncarcinogenic effects and LADDs for carcinogenic effects were estimated using exposure point concentrations and assumptions to characterize human exposure to COPCs from the site via oral and dermal pathways. ADDs/LADDs were then compared to relevant toxicity criteria to calculate risks associated with the evaluated exposures. The resulting risk estimates

were the upper-bound excess lifetime cancer risks for carcinogenic chemicals and hazard indices for noncarcinogenic chemicals. Using the risk or hazard index values, risks and potential adverse effects from exposure to site-related chemicals were assessed. Cancer risk estimates were compared to USEPA's target risk range for health protectiveness at Superfund sites of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$ , as recommended by USEPA (1990b). The potential for adverse noncarcinogenic effects was assessed by comparing the noncarcinogenic hazard indices to a value of one; a hazard index less than one indicates that adverse noncarcinogenic health effects would not be expected to occur. The following sections summarize the cumulative risk results of the quantitative HHRA.

### 3.7.1 Current Land-Use

The cumulative risks for trespassers/recreational users was  $3 \times 10^{-5}$  for the PCBs Area and  $2 \times 10^{-7}$  at the Pesticides Area, which are either lower than or in the mid range of the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range for health protectiveness at Superfund sites. The cumulative hazard index was below one at both areas, indicating that adverse noncarcinogenic effects would not be likely to occur, based on exposures through all pathways.

### 3.7.2 Future Land-Use

The cumulative risk for workers was  $1 \times 10^{-4}$  for the PCBs Area and  $2 \times 10^{-8}$  for the Pesticides Area, either lower than or at the high end of the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range.

The cumulative risk for future environmental educators were  $1 \times 10^{-4}$  for the PCBs Area and  $1 \times 10^{-6}$  for the Pesticides Area, either at the low or high end of the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range for health protectiveness at Superfund sites. The cumulative hazard index was below one at both areas, indicating that adverse noncarcinogenic effects would not be likely to occur, based on exposures through all pathways.

The cumulative risk for child residents was  $2 \times 10^{-4}$  for the PCBs Area and  $5 \times 10^{-7}$  for the Pesticides Area, either lower than or just above the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range. The cumulative hazard index was above one (5) for the PCBs Area, while the cumulative hazard index was below one for the Pesticides Area.

The cumulative risk for adult residents was  $5 \times 10^{-3}$ , above the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range. The cumulative hazard index for adults was above one (2).

### 3.7.3 Overall Risks at Operable Unit Three

The most significant risks associated with exposures to evaluated media at OU3 are associated with ingestion of fish by hypothetical future residents. Even though elevated risks were calculated for this receptor, however, it should be noted that this pathway is considered to be highly unlikely for several reasons. First, residents would not likely reside at WRF, since the facility will be transferred to the USFWS. Second, individuals would not likely fish at OU3 ditches, since there are other areas at WRF with much better fishing (e.g., Belmont and Occoquan Bays, Marumsco Creek, and the pond at WRF). Finally, the ditches do not support great quantities or sizes of fish to allow for significant ingestion exposures. In addition, the species associated with the greatest risks (i.e., eel) is not a species that would likely be consumed at all.

Risks associated with exposures to COPCs in sediment and surface water were within or below the  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  risk range for all receptors and both areas, while all noncancer hazard indices were lower than one, indicating the noncarcinogenic adverse effects would not be likely to occur. Risks associated with exposures to groundwater were within the target risk range, but the hazard indices were above one (due to two inorganics). Finally, risks associated with exposures to soil were elevated for most receptors (due to benzo[a]pyrene).

**Appendix A**  
**Human Health Risk Assessment for Operable Unit Three**  
**Tables**

**TABLE 3-1**  
**REGION III RISK-BASED CONCENTRATIONS (RBCs)**  
**FOR DETECTED CHEMICALS AT OU3**

Chemical	RBC Value (a)
<b><u>Residential Soil (mg/kg)</u></b>	
<b>Organics:</b>	
Acenaphthene	470
Anthracene	2,300
Benzo(a)anthracene	0.88
Benzo(a)pyrene	0.088
Benzo(b)fluoranthene	0.88
Benzo(g,h,i)perylene	230(b)
Benzo(k)fluoranthene	8.8
Benzoic Acid	31,000
Chlordane (total)	0.49
alpha-Chlordane	0.49(c)
gamma-Chlordane	0.49(c)
Chrysene	88
DDD	2.7
DDE	1.9
DDT	1.9
Dibenzo(a,h)anthracene	0.088
Dibenzofuran	31
bis(2-Ethylhexyl)phthalate	46
Fluoranthene	310
Fluorene	310
Indeno(1,2,3-c,d)pyrene	0.88
1-Methylnaphthalene	230(b)
2-Methylnaphthalene	230(b)
Naphthalene	310
PCB-1260	0.083(d)
Phenanthrene	230(b)
Pyrene	230
<b>Inorganics:</b>	
Aluminum	7,800
Arsenic	0.43
Barium	550
Beryllium	0.15
Calcium	4,000,000(e)
Chromium	39(f)
Cobalt	470
Copper	310
Iron	2,300
Lead	400(g)
Magnesium	800,000(e)
Manganese	156
Nickel	160
Potassium	1,000,000(e)
Selenium	39
Sodium	1,000,000(e)
Vanadium	55
Zinc	2,300
<b><u>Tap Water (ug/L)</u></b>	
<b>Organics:</b>	
Acenaphthylene	110

**TABLE 3-1**  
**REGION III RISK-BASED CONCENTRATIONS (RBCs)**  
**FOR DETECTED CHEMICALS AT OU3**

Chemical	RBC Value (a)
Acetone	370
Anthracene	1,100
Dieldrin	0.0042
Endosulfan sulfate	22
Fluoranthene	150
Phenanthrene	110
Pyrene	110
<b>Inorganics:</b>	
Aluminum	3,700
Arsenic	0.045
Barium	260
Cadmium	1.8
Calcium	400,000(e)
Chromium	18(f)
Copper	150
Iron	1,100
Lead	15(g)
Magnesium	80,500(e)
Manganese	88
Potassium	100,000(e)
Selenium	18
Silver	18
Sodium	100,000(e)
Thallium	0.29(h)
Vanadium	26
Zinc	1,100
<b>Fish (mg/kg)</b>	
<b>Organics:</b>	
delta BHC	0.0000005(i)
alpha-Chlordane	0.0000024(c)
gamma-Chlordane	0.0000024(c)
DDD	0.000013
DDE	0.0000093
Methoxychlor	0.00068
PCB-1260	0.00000041(d)
<b>Inorganics:</b>	
Mercury	0.041(l)
<b>Industrial Soil (mg/kg)</b>	
<b>Organics:</b>	
PCB-1260	.74 (d)
<b>Inorganics:</b>	
Aluminum	100,000
Barium	14,000
Beryllium	1.3
Calcium	4,000,000(e)
Chromium	1000(f)
Cobalt	12,000
Copper	8,200
Iron	61,000
Lead	400(g)



**TABLE 3-1**  
**REGION III RISK-BASED CONCENTRATIONS (RBCs)**  
**FOR DETECTED CHEMICALS AT OU3**

Chemical	RBC Value (a)
Magnesium	800,000(e)
Manganese	4,700
Nickel	4,100
Potassium	1,000,000(e)
Selenium	1,000
Sodium	1,000,000(e)
Vanadium	1,400
Zinc	61,000

- (a) RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following USEPA Region III guidance.
- (b) The RBC for pyrene was used for noncarcinogenic polycyclic aromatic hydrocarbons (PAHs) lacking RBCs.
- (c) The RBC for chlordane was used.
- (d) The RBC for carcinogenic PCBs was used.
- (e) Value is an allowable daily intake (ADI) level.
- (f) The RBC for chromium VI was used.
- (g) Because no RBC exists for lead, the residential soil screening level USEPA (1994b) was used for sediment and the action level USEPA (1990c) was used for surface water.
- (h) The most conservative RBC for thallium salts was used.
- (i) The RBC for alpha BHC was used.
- (j) The RBC for endosulfan was used.
- (l) The RBC for methyl mercury was used.

TABLE 3-2  
SUMMARY OF CHEMICALS DETECTED IN OU3 SEDIMENT  
PCBs AND PESTICIDES AREAS  
(Concentrations in mg/kg)

Chemical	Frequency of Detection (a)	Arithmetic Mean (b)	Range of Detection Limits	Range of Detected Concentrations	Residential Soil RBC (c)	Maximum Detect > RBC?	Range of Background Concentrations (d)	Site > Background (e)
<b>PCBs Area</b>								
<b>Organics:</b>								
Acenaphthene	1 / 5	0.315	0.133	1.31	470	No	0.6683 - 0.919	---
Anthracene	5 / 5	0.0624	NU	0.0230 - 0.155	2,300	No	0.108 - 0.1685	---
Benzo(a)anthracene	3 / 4	0.163	0.0130	0.0220 - 0.591	0.88	No	0.0210 - 0.0310	---
* Benzo(a)pyrene	4 / 4	0.235	NU	0.0540 - 0.596	0.088	Yes	0.0290 - 0.0515	---
Benzo(b)fluoranthene	5 / 5	0.124	NU	0.00900 - 0.347	0.88	No	0.0610 - 0.0830	---
Benzo(g,h,i)perylene	2 / 5	0.0396	0.00700 - 0.168	0.0210 - 0.0560	230	No	0.0460 - 0.0800	---
Benzo(k)fluoranthene	3 / 4	0.0685	0.0180	0.0200 - 0.197	8.8	No	0.0170 - 0.0320	---
Benzoic Acid	1 / 5	0.299	0.1 - 0.3	1.0	31,000	No	ND	---
Chrysene	1 / 1	NC	NU	0.480	88	No	ND	---
DDD	1 / 5	0.00600	0.00300	0.0240	2.7	No	ND	---
Dibenzo(a,h)anthracene	1 / 5	0.0146	0.00300 - 0.0830	0.0120	0.088	No	0.0130 - 0.0220	---
Fluoranthene	4 / 4	0.286	NU	0.104 - 0.768	310	No	0.0550 - 0.0940	---
Fluorene	1 / 5	0.0758	0.0330	0.313	310	No	0.1568 - 0.355	---
Indeno(1,2,3-c,d)pyrene	2 / 5	0.0641	0.0030 - 0.0830	0.0340 - 0.227	0.88	No	0.0640 - 0.112	---
2-Methylnaphthalene	2 / 2	1.51	NU	1.24 - 1.78	230	No	ND	---
Naphthalene	3 / 5	0.794	0.133	0.380 - 2.90	310	No	0.351	---
* PCB-1260	5 / 5	2.26	NU	0.0430 - 6.04	0.083	Yes	ND	---
Phenanthrene	3 / 5	0.397	0.0330	0.356 - 0.915	230	No	ND	---
Pyrene	3 / 3	0.384	NU	0.0650 - 0.955	230	No	0.0530 - 0.130	---
<b>Inorganics:</b>								
b Aluminum	5 / 5	12,300	NU	8,980 - 15,900	7,800	Yes	10,500 - 15,200	No
Barium	5 / 5	143	NU	75.8 - 191	550	No	175	---
b Beryllium	5 / 5	1.44	NU	1.03 - 2.44	0.15	Yes	0.989 - 1.26	No
Calcium	4 / 4	1,890	NU	1,300 - 2,410	400,000	No	4,240 - 6,000	---
Chromium	5 / 5	17.9	NU	13.3 - 23.0	39	No	21.6 - 30.1	---
Cobalt	5 / 5	21.4	NU	8.50 - 36.1	470	No	14.6 - 20.7	---
Copper	5 / 5	19.8	NU	12.5 - 25.9	310	No	29.8 - 41.8	---
b Iron	5 / 5	16,500	NU	10,300 - 19,400	2,300	Yes	26,100 - 34,200	No
Lead	5 / 5	36.3	NU	20.9 - 50.6	400	No	22,775 - 42.2	---
Magnesium	5 / 5	1,420	NU	1,010 - 1,760	80,500	No	2,470 - 3,470	---
b Manganese	5 / 5	396	NU	216 - 564	190	Yes	911.5 - 1,690	No
Nickel	5 / 5	14.0	NU	7.72 - 19.1	160	No	19.3 - 30.0	---

**TABLE 3-2**  
**SUMMARY OF CHEMICALS DETECTED IN OU3 SEDIMENT**  
**PCBs AND PESTICIDES AREAS**  
**(Concentrations in mg/kg)**

Chemical	Frequency of Detection (a)	Arithmetic Mean (b)	Range of Detection Limits	Range of Detected Concentrations	Residential Soil RBC (c)	Maximum Detect? RBC?	Range of Background Concentrations (d)	Site > Background (e)
Sodium	5 / 5	977	NU	565 - 1,240	100,000	No	932 - 1,710	---
b Vanadium	5 / 5	42.6	NU	28.9 - 57.9	55	Yes	35.5 - 52.5	No
Zinc	5 / 5	147	NU	63.2 - 257	2,300	No	114 - 157	---
<b>Pesticides Area</b>								
<b>Organics:</b>								
Anthracene	5 / 5	0.0922	NU	0.0280 - 0.190	2,300	No	0.108 - 0.1685	---
Benzo(a)anthracene	4 / 4	0.0288	NU	0.0130 - 0.0490	0.88	No	0.0210 - 0.0310	---
* Benzo(a)pyrene	5 / 5	0.0494	NU	0.0150 - 0.109	0.088	Yes	0.0290 - 0.0515	---
Benzo(b)fluoranthene	5 / 5	0.0640	NU	0.0200 - 0.120	0.88	No	0.0610 - 0.0830	---
Benzo(g,h,i)perylene	4 / 5	0.0505	0.00700	0.0280 - 0.0910	230	No	0.0460 - 0.0800	---
Benzo(k)fluoranthene	5 / 5	0.0312	NU	0.0100 - 0.0570	8.8	No	0.0170 - 0.0320	---
Benzoic Acid	1 / 5	0.788	0.140 - 0.700	3.10	31,000	No	ND	---
Chlordane	2 / 5	0.0668	0.0200	0.0410 - 0.263	0.49	No	ND	---
alpha-Chlordane	2 / 5	0.00830	0.00300	0.0160 - 0.021	0.49	No	ND	---
gamma-Chlordane	2 / 5	0.0113	0.00300	0.0220 - 0.0300	0.49	No	ND	---
DDD	1 / 5	0.00440	0.00300	0.0160	2.7	No	ND	---
Dibenzo(a,h)anthracene	2 / 5	0.00610	0.00300	0.0120 - 0.0140	0.088	No	0.0130 - 0.0220	---
Fluoranthene	5 / 5	0.0900	NU	0.0310 - 0.167	310	No	0.0550 - 0.0940	---
Fluorene	1 / 5	0.105	0.0330	0.459	310	No	0.1568 - 0.355	---
Indeno(1,2,3-c,d)pyrene	5 / 5	0.0352	NU	0.0120 - 0.0720	0.88	No	0.0640 - 0.112	---
Naphthalene	1 / 5	0.225	0.133	0.858	310	No	0.351	---
Pyrene	3 / 4	0.107	0.00700	0.0780 - 0.219	230	No	0.0530 - 0.130	---
<b>Inorganics:</b>								
b Aluminum	5 / 5	13,900	NU	10,600 - 15,600	7,800	Yes	10,500 - 15,200	No
Barium	5 / 5	138	NU	86.3 - 187	550	No	175	---
b Beryllium	5 / 5	1.22	NU	0.715 - 1.93	0.15	Yes	0.989 - 1.26	No
Calcium	4 / 4	1,890	NU	1,330 - 2,370	400,000	No	4,240 - 6,000	---
Chromium	5 / 5	19.5	NU	15.5 - 22.6	39	No	21.6 - 30.1	---
Cobalt	5 / 5	12.7	NU	8.19 - 19.1	470	No	14.6 - 20.7	---
Copper	5 / 5	18.9	NU	14.0 - 24.0	310	No	29.8 - 41.8	---
b Iron	5 / 5	22,200	NU	17,100 - 34,600	2,300	Yes	26,100 - 34,200	No
Lead	5 / 5	55.9	NU	36.4 - 84.5	400	No	22,775 - 42.2	---
Magnesium	4 / 4	1,560	NU	1,200 - 1,830	80,500	No	2,470 - 3,470	---
b Manganese	3 / 3	356	NU	315 - 391	190	Yes	911.5 - 1,690	No

**TABLE 3-2**  
**SUMMARY OF CHEMICALS DETECTED IN OU3 SEDIMENT**  
**PCBs AND PESTICIDES AREAS**  
**(Concentrations in mg/kg)**

Chemical	Frequency of Detection (a)	Arithmetic Mean (b)	Range of Detection Limits	Range of Detected Concentrations	Residential Soil RBC (c)	Maximum Detect > RBC?	Range of Background Concentrations (d)	Site > Background (e)
Nickel	5 / 5	12.0	NU	8.0 - 15.2	160	No	19.3 - 30.0	---
Potassium	2 / 2	1,020	NU	991 - 1,040	100,000	No	1,450 - 2,120	---
Sodium	5 / 5	762	NU	599 - 944	100,000	No	932 - 1,710	---
Vanadium	5 / 5	51.9	NU	44.1 - 68.8	55	Yes	35.5 - 52.5	No
Zinc	5 / 5	109	NU	57.6 - 194	2,300	No	114 - 157	---

(a) The number of samples in which the chemical was detected divided by the total number of samples analyzed.

(b) Calculated by averaging the detected concentration(s) with one-half the detection limit of non-detected sample(s).

(c) See Table 3-1 for a list of all residential soil RBCs. Calcium, magnesium, potassium, and sodium are essential nutrients and do not have RBCs. Maximum concentrations of these chemicals were compared to allowable daily intake (ADI) levels.

(d) Background concentrations were site-specific and are discussed in Section 2 of the FFS.

(e) Statistical comparisons to background were not performed on organics or on inorganic chemicals with a maximum concentration below respective RBCs or ADIs.

NC = Not calculated, since only one sample was available to calculate a mean concentration.

ND = Not Detected.

NU = Not used. The chemical was detected in all samples, thus detection limits were not used to calculate mean concentrations.

b = Chemical was detected at concentrations above its residential soil RBC or ADI but within background levels (the background comparison was conducted only for inorganic chemicals), and evaluated separately from site-related chemicals.

\* = Selected as a COPC.

**TABLE 3-3**  
**SUMMARY OF CHEMICALS DETECTED IN OU3 SURFACE WATER**  
**PCBs & PESTICIDES AREAS**  
**(Concentrations in µg/L)**

Chemical	Frequency of Detection (a)	Arithmetic Mean (b)	Range of Detection Limits	Range of Detected Concentrations	Tap Water RBC (c)	Maximum Detect > RBC?	Range of Background Concentrations (d)	Site > Background? (e)
<b>PCBs Area</b>								
<b>Inorganics:</b>								
* Aluminum	5 / 5	12,400	NU	10,500 - 13,200	3,700	Yes	1,230 - 1,930	Yes
Barium	5 / 5	66.2	NU	58.2 - 70.0	260	No	37.7 - 41.8	---
Cadmium	4 / 5	0.130	0.100	0.100 - 0.300	1.8	No	ND	---
Calcium	5 / 5	5,920	NU	4,970 - 6,580	400,000	No	18,800 - 22,200	---
Chromium	3 / 5	9.62	10.0	11.1 - 14.8	18	No	10.8	---
Copper	5 / 5	6.74	NU	5.10 - 7.60	150	No	ND	---
* Iron	5 / 5	9,900	NU	7,900 - 10,800	1,100	Yes	1,905 - 2,510	Yes
Lead	5 / 5	7.22	NU	4.80 - 8.0	15	No	1.30 - 1.90	---
Magnesium	5 / 5	2,520	NU	2,460 - 2,570	80,500	No	5,970 - 7,500	---
b Manganese	5 / 5	238	NU	171 - 318	88	Yes	176 - 303	No
Potassium	5 / 5	3,660	NU	3,530 - 3,990	100,000	No	2,870 - 3,670	---
Sodium	5 / 5	2,230	NU	2,130 - 2,350	100,000	No	12,500 - 16,500	---
Thallium	4 / 5	0.130	0.100	0.100 - 0.200	0.29	No	ND	---
Vanadium	5 / 5	23.2	NU	17.5 - 25.3	26	No	ND	---
Zinc	5 / 5	43.9	NU	30.7 - 50.4	1,100	No	ND	---
<b>Pesticides Area</b>								
<b>Organics:</b>								
Fluoranthene	2 / 5	0.0158	0.0200	0.023 - 0.026	150	No	ND	---
<b>Inorganics:</b>								
* Aluminum	5 / 5	13,800	NU	11,900 - 16,100	3,700	Yes	1,230 - 1,930	Yes
Barium	5 / 5	77.5	NU	68.1 - 109	260	No	37.7 - 41.8	---
Cadmium	3 / 5	0.100	0.100	0.1 - 0.2	1.8	No	ND	---
Calcium	5 / 5	7,370	NU	4,840 - 8,600	400,000	No	18,800 - 22,200	---
Chromium	5 / 5	11.5	NU	10.3 - 12.6	18	No	10.8	---
Copper	5 / 5	7.40	NU	6.5 - 8.2	150	No	ND	---
* Iron	5 / 5	12,900	NU	11,300 - 17,300	1,100	Yes	1,905 - 2,510	Yes
Lead	4 / 5	7.82	1.0	7.6 - 13	15	No	1.30 - 1.90	---
Magnesium	5 / 5	2,790	NU	2,660 - 2,900	80,500	No	5,970 - 7,500	---
* Manganese	5 / 5	499	NU	339 - 624	88	Yes	176 - 303	Yes
Potassium	5 / 5	3,940	NU	3,520 - 4,280	100,000	No	2,870 - 3,670	---
Sodium	5 / 5	2,460	NU	2,110 - 2,650	100,000	No	12,500 - 16,500	---

**TABLE 3-3**  
**SUMMARY OF CHEMICALS DETECTED IN OU3 SURFACE WATER**  
**PCBs & PESTICIDES AREAS**  
**(Concentrations in µg/L)**

Chemical	Frequency of Detection (a)	Arithmetic Mean (b)	Range of Detection Limits	Range of Detected Concentrations	Tap Water RBC (c)	Maximum		Site > Background? (e)
						Detect > RBC?	Range of Background Concentrations (d)	
Thallium	4 / 5	0.150	0.100	0.1 - 0.2	0.29	No	ND	---
* Vanadium	5 / 5	27.0	NU	24.7 - 30.1	26	Yes	ND	Yes
Zinc	5 / 5	50.2	NU	41.2 - 78	1,100	No	ND	---

(a) The number of samples in which the chemical was detected divided by the total number of samples analyzed.

(b) Calculated by averaging the detected concentration(s) with one-half the detection limit of non-detected sample(s).

(c) See Table 3-1 for a list of all Tap Water RBCs. Calcium, magnesium, potassium, and sodium are essential nutrients and do not have RBCs. Maximum concentrations of these chemicals were compared to allowable daily intake (ADI) levels.

(d) Background concentrations were site-specific and are discussed in Section 2 of the FFS.

(e) Statistical comparisons to background were not performed on organics or on inorganic chemicals with a maximum concentration below respective RBCs or ADIs.

ND = Not Detected.

NU = Not used. The chemical was detected in all samples, thus detection limits were not used to calculate mean concentrations.

b = Chemical was detected at concentrations above its Tap Water RBC or ADI but within background levels and was evaluated separately from site-related chemicals.

\* = Selected as a COPC.

TABLE 3-4  
SUMMARY OF CHEMICALS DETECTED IN OU3 FISH-FILLET TISSUE  
DITCH AREA  
(Concentrations in ug/kg-wet organics and ug/g-wet inorganics)

Chemical	Frequency of Detection (a)	Arithmetic Mean (b)	Range of Detection Limits	Range of Detected Concentrations	Fish RBC (c)	Maximum Detect > RBC?
<b>Bass</b>						
<b>Organics:</b>						
* DDD	5 / 5	16.4	NU	12.2 - 24.4	1.3E+01	Yes
* DDE	5 / 5	13.6	NU	10.2 - 19.3	9.3E+00	Yes
* PCB-1260	5 / 5	103	NU	68.5 - 157	1.6E+00	Yes
<b>Inorganics:</b>						
* Mercury	5 / 5	0.101	NU	0.0970 - 0.107	1.4E-02	Yes
<b>Carp</b>						
<b>Organics:</b>						
alpha Chlordane	1 / 3	1.03	1.0	2.08	2.4E+00	No
* gamma Chlordane	1 / 3	1.67	1.0	4.0	2.4E+00	Yes
* DDD	3 / 3	33.5	NU	13.5 - 67.2	1.3E+01	Yes
* DDE	3 / 3	22.6	NU	14.0 - 35.3	9.3E+00	Yes
* PCB-1260	3 / 3	143	NU	79.2 - 224	1.6E+00	Yes
<b>Crappie</b>						
<b>Organics:</b>						
* DDE	5 / 5	87.4	NU	61.4 - 108	9.3E+00	Yes
* PCB-1260	5 / 5	736	NU	548 - 853	1.6E+00	Yes
<b>Inorganics:</b>						
* Mercury	5 / 5	0.064	NU	0.0560 - 0.0770	1.4E-02	Yes
<b>Eel</b>						
<b>Organics:</b>						
* delta BHC	4 / 5	6.13	1.0	2.95 - 15.2	NRA	Yes
* DDD	4 / 5	95.7	1.0	24.4 - 281	1.3E+01	Yes
* DDE	5 / 5	102	NU	40.0 - 223	9.3E+00	Yes
* PCB-1260	5 / 5	1,440	NU	324 - 4,380	1.6E+00	Yes
<b>Inorganics:</b>						
* Mercury	2 / 5	0.0485	0.0480 - 0.0500	0.0670 - 0.102	1.4E-02	Yes

**TABLE 3-4**  
**SUMMARY OF CHEMICALS DETECTED IN OU3 FISH-FILLET TISSUE**  
**DITCH AREA**  
**(Concentrations in ug/kg-wet organics and ug/g-wet inorganics)**

Chemical	Frequency of Detection (a)	Arithmetic Mean (b)	Range of Detection Limits	Range of Detected Concentrations	Fish RBC (c)	Maximum Detect > RBC?
<b>Sunfish</b>						
<b>Organics:</b>						
* DDE	2 / 4	3.68	1.0	3.11 - 10.6	9.3E+00	<b>Yes</b>
* PCB-1260	3 / 4	37.5	20.0	33.7 - 53.7	1.6E+00	<b>Yes</b>
<b>White Perch</b>						
<b>Organics:</b>						
DDE	3 / 5	2.57	1.0	2.78 - 5.90	9.3E+00	No
Methoxychlor	1 / 5	20	1.0	98.0	6.8E+02	No
* PCB-1260	1 / 5	12.4	20.0	22.1	1.6E+00	<b>Yes</b>
<b>Inorganics:</b>						
* Mercury	5 / 5	0.0940	NU	0.0850 - 0.107	1.4E-02	<b>Yes</b>

(a) The number of samples in which the chemical was detected divided by the total number of samples analyzed.

(b) Calculated by averaging the detected concentration(s) with one-half the detection limit of non-detected sample(s).

(c) See Table 3-1 for a list of all fish RBCs. Fish RBCs for organics are in ug/kg, while fish RBCs for inorganics are in ug/g.

NU = Not used. The chemical was detected in all samples, thus detection limits were not used to calculate mean concentrations.

NRA = No RBC Available.

\* = Selected as a COPC.



**TABLE 3-5**  
**COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS**  
**IN OU3 SURFACE WATER TO HUMAN HEALTH AWQCs**  
**PCBs & PESTICIDES AREAS**  
**(Concentrations in ug/L)**

Chemical	Maximum Detected Concentration	Quality Criteria for Water & Organism	
		Human Health 1X10 <sup>-6</sup> Risk Level for Carcinogens	Maximum Detect > Criterion?
<b>PCBs Area</b>			
<b>Inorganics:</b>			
Aluminum	13,200	No value given	(a)
Barium	70.0	1,000 (b)	No
Cadmium	0.300	10 (b)	No
Calcium	6,580	No value given	(a)
Chromium (VI)	14.8	50 (b)	No
Copper	7.60	1,300	No
Iron	10,800	300 (b)	<b>Yes</b>
Lead	8.0	50 (b)	No
Magnesium	2,570	No value given	(a)
Manganese	318	50 (b)	<b>Yes</b>
Potassium	3,990	No value given	(a)
Sodium	2,350	No value given	(a)
Thallium	0.200	1.7	No
Vanadium	25.3	No value given	(a)
Zinc	50.4	No value given	(a)
<b>Pesticides Area</b>			
<b>Organics:</b>			
Fluoranthene	0.026	300	No
<b>Inorganics:</b>			
Aluminum	16,100	No value given	(a)
Barium	109	1,000 (b)	No
Cadmium	0.2	10 (b)	No
Calcium	8,600	No value given	(a)
Chromium (VI)	12.6	50 (b)	No
Copper	8.2	1,300	No
Iron	17,300	300 (b)	<b>Yes</b>
Lead	13	50 (b)	No
Magnesium	2,900	No value given	(a)
Manganese	624	50 (b)	<b>Yes</b>
Potassium	4,280	No value given	(a)
Sodium	2,650	No value given	(a)
Thallium	0.2	1.7	No
Vanadium	30.1	No value given	(a)
Zinc	78	No value given	(a)

(a) No value given in the 1995 Draft Quality Criteria for water.

(b) Because the "Water and Organisms" value based on IRIS toxicity criterion was not available, the value shown is the published criterion.

**TABLE 3-6**  
**SUMMARY OF CHEMICALS DETECTED IN OU3 GROUNDWATER**  
**PCBs AREA**  
(Concentrations in µg/L)

Chemical	Frequency of Detection (a)	Arithmetic Mean (b)	Range of Detection Limits	Range of Detected Concentrations	Tap Water RBC (c)	Maximum Detected > RBC?	Range of Background Concentrations (d)	Site > Background? (e)
<b>PCBs Area</b>								
<b>Organics:</b>								
Acenaphthylene	1 / 15	1.08	2.0	2.19	110	No	2.01 - 6.34	---
Acetone	1 / 13	6.62	10.0	26.0	370	No	ND	---
Anthracene	2 / 15	0.144	0.100	0.305 - 1.20	1,100	No	0.113 - 2.38	---
* Dieldrin	1 / 15	0.0029	0.0050	0.0090	0.0042	Yes	0.0220	---
Endosulfan sulfate	1 / 15	0.0033	0.0050	0.0150	22	No	0.0108 - 0.146	---
Phenanthrene	2 / 15	0.460	0.500	0.715 - 2.93	110	No	6.39 - 8.69	---
Pyrene	1 / 15	0.0593	0.100	0.190	110	No	0.150 - 0.158	---
<b>Inorganics:</b>								
Aluminum	12 / 12	475	NU	96.1 - 1,450	3,700	No	94.8 - 12,500	---
b Arsenic	7 / 15	1.67	1.0	1.10 - 5.0	0.045	Yes	1.10 - 6.70	No
Barium	14 / 15	47.8	25.0	28.4 - 81.8	260	No	28.8 - 107	---
Cadmium	3 / 15	0.0850	0.100	0.0750 - 0.300	1.8	No	0.100 - 0.800	---
Calcium	15 / 15	6,270	NU	1,940 - 29,000	400,000	No	2,250 - 42,200	---
* Iron	15 / 15	8,750	NU	77.2 - 18,000	1,100	Yes	159 - 9,620	Yes
Lead	1 / 15	0.653	1.0	2.80	15	No	0.850 - 6.30	---
Magnesium	15 / 15	2,390	NU	1,355 - 4,040	80,500	No	191 - 7,720	---
* Manganese	15 / 15	306	NU	42.2 - 562	84	Yes	6.65 - 354	Yes
Potassium	15 / 15	973	NU	592 - 1,710	100,000	No	744 - 20,600	---
Selenium	1 / 15	1.05	2.0	1.70	18	No	2.10 - 4.20	---
Silver	1 / 15	3.05	5.0	10.7	18	No	ND	---
Sodium	11 / 11	7,310	NU	5,180 - 10,055	100,000	No	5,110 - 43,500	---
Zinc	6 / 15	48.1	20.0	20.4 - 216	1,100	No	20.3 - 46.0	---

(a) The number of samples in which the chemical was detected divided by the total number of samples analyzed, excluding samples rejected as a result of data validation.

(b) Calculated by averaging the detected concentration(s) with one-half the detection limit of non-detected sample(s).

(c) See Table 3-1 for a list of all Tap Water RBCs. Calcium, magnesium, potassium, and sodium are essential nutrients and do not have RBCs. Maximum concentrations of these chemicals were compared to allowable daily intake (ADI) levels.

(d) Background concentrations are from samples MW-52 through MW-54, and MW-63. MW-52 through MW-54 were sampled in two rounds and MW-63 was sampled in three rounds.

(e) Statistical comparisons to background data were performed only for inorganics that exceed respective RBCs or ADIs.

b = Chemical was detected at concentrations above its tap water RBC or ADI but within background levels and was evaluated separately from site-related chemicals.

ND = Not detected.

NU = Not used. The chemical was detected in all samples, thus detection limits were not used to calculate mean concentrations.

\* = Selected as a COPC.

TABLE 3-7  
SUMMARY OF CHEMICALS DETECTED IN OU3 SURFACE SOIL  
PCBs AREA  
(Concentrations in mg/kg)

Chemical	Frequency of Detection (a)	Arithmetic Mean (b)	Range of Detection Limits	Range of Detected Concentrations	Residential Soil RBC (c)	Maximum Detected > RBC?	Range of Background Concentrations (d)	Site > Background? (e)
<b>PCBs Area</b>								
<b>Organics:</b>								
Acenaphthene	1 / 11	0.893	0.133 - 0.270	9.0	470	No	ND	---
Anthracene	3 / 11	0.510	0.0070 - 0.170	0.0140 - 5.0	2,300	No	0.0150 - 0.0280	---
* Benzo(a)anthracene	4 / 11	0.958	0.140 - 0.170	0.0020 - 10.0	0.88	Yes	0.0030 - 0.0050	---
* Benzo(a)pyrene	4 / 11	0.783	0.140 - 0.240	0.0060 - 8.0	0.088	Yes	0.0020 - 0.0080	---
* Benzo(b)fluoranthene	4 / 11	1.01	0.140 - 0.730	0.0140 - 10.0	0.88	Yes	0.0013 - 0.0100	---
Benzo(g,h,i)perylene	4 / 11	0.300	0.160 - 0.250	0.0140 - 2.60	230	No	0.0110	---
Benzo(k)fluoranthene	4 / 11	0.617	0.140 - 0.400	0.0060 - 6.0	8.8	No	0.001 - 0.0050	---
Chrysene	3 / 11	0.972	0.0070 - 0.270	0.0140 - 10.0	88	No	ND	---
DDE	3 / 11	0.0336	0.0030 - 0.0142	0.0070 - 0.320	1.9	No	ND	---
DDT	3 / 11	0.0565	0.0030 - 0.0096	0.0270 - 0.540	1.9	No	ND	---
* Dibenzo(a,h)anthracene	1 / 11	0.129	0.0030 - 0.270	0.740	0.088	Yes	ND	---
Dibenzofuran	1 / 11	0.303	0.140 - 0.170	2.60	31	No	ND	---
bis(2-Ethylhexyl)phthalate	1 / 8	0.0931	0.140 - 0.190	0.180	46	No	0.180 - 0.500	---
Fluoranthene	4 / 11	2.78	0.140 - 0.170	0.0130 - 30.0	310	No	0.0055 - 0.0180	---
Fluorene	1 / 11	0.415	0.0330 - 0.170	4.0	310	No	ND	---
* Indeno(1,2,3-c,d)pyrene	4 / 11	0.290	0.140 - 0.170	0.0220 - 2.60	0.88	Yes	0.0080 - 0.0100	---
1-Methylnaphthalene	1 / 3	3.78	0.133	11.2	230	No	ND	---
2-Methylnaphthalene	1 / 11	0.184	0.133 - 0.170	1.30	230	No	ND	---
Naphthalene	1 / 11	0.429	0.133 - 0.170	4.0	310	No	ND	---
* PCB-1260	7 / 11	0.178	0.0130 - 0.400	0.0210 - 0.702	0.083	Yes	ND	---
Phenanthrene	1 / 11	2.78	0.0330 - 0.170	30.0	230	No	0.0420 - 0.354	---
Pyrene	4 / 11	1.95	0.140 - 0.970	0.0200 - 20.0	230	No	0.0090 - 0.0230	---
<b>Inorganics:</b>								
b Aluminum	10 / 10	6,160	NU	596 - 10,900	7,800	Yes	4,740 - 14,350	No
b Arsenic	5 / 11	3.26	7.50	1.55 - 4.30	0.43	Yes	3.24 - 3.80	No
Barium	10 / 11	55.6	4.87	6.64 - 98.0	550	No	67.0 - 92.4	---
b Beryllium	8 / 11	0.505	0.250	0.387 - 0.976	0.15	Yes	0.300 - 0.814	No
Calcium	3 / 6	329	109	339 - 777	4,000,000	No	486 - 1,150	---
Chromium	10 / 11	9.91	0.974	1.74 - 20.2	39	No	9.42 - 31.3	---
Cobalt	8 / 11	6.28	2.50	4.94 - 10.9	470	No	2.47 - 16.6	---
Copper	9 / 11	9.45	3.38	6.14 - 31.5	310	No	4.83 - 12.6	---
b Iron	11 / 11	9,430	NU	1,120 - 16,500	2,300	Yes	7,630 - 28,100	No
Lead	10 / 11	30.9	7.50	11.3 - 166	400	No	15.5 - 22.4	---
Magnesium	8 / 11	752	138	591 - 1,460	800,000	No	881 - 2,610	---

TABLE 3-7  
SUMMARY OF CHEMICALS DETECTED IN OU3 SURFACE SOIL  
PCBs AREA  
(Concentrations in mg/kg)

Chemical	Frequency of Detection (a)	Arithmetic Mean (b)	Range of Detection Limits	Range of Detected Concentrations	Residential Soil RBC (c)	Maximum Detected > RBC?	Range of Background Concentrations (d)	Site > Background? (e)
b Manganese	11 / 11	387	NU	46.4 - 788	180	Yes	112 - 875	No
Nickel	8 / 11	5.44	7.50	3.83 - 8.04	160	No	2.83 - 11.9	---
Potassium	4 / 7	293	142	257 - 911	1,000,000	No	358 - 936	---
Selenium	1 / 11	6.26	10.0 - 12.4	15.3	39	No	14.2	---
Sodium	3 / 6	224	50.0	394 - 450	1,000,000	No	380 - 487	---
Vanadium	11 / 11	21.6	NU	2.69 - 37.6	55	No	19.9 - 58.9	---
Zinc	11 / 11	49.6	NU	11.1 - 212	2,300	No	14.8 - 43.9	---

(a) The number of samples in which the chemical was detected divided by the total number of samples analyzed, excluding samples rejected as a result of data validation.

(b) Calculated by averaging the detected concentration(s) with one-half the detection limit of non-detected sample(s).

(c) See Table 3-1 for a list of all residential soil RBCs. Calcium, magnesium, potassium, and sodium are essential nutrients and do not have RBCs. Maximum concentrations of these chemicals were compared to allowable daily intake (ADI) levels.

(d) Background concentrations are from samples MW-52 through MW-54 and RIBKSS-1 through 5.

(e) Statistical comparisons to background were performed only for inorganics that exceed respective RBCs or ADIs, and that had at least five site and five background samples.

b = Chemical was detected at concentrations above its residential soil RBC or ADI, but within background levels and was evaluated separately from site related chemicals.

ND = Not detected.

NU = Not used. The chemical was detected in all samples, thus detection limits were not used to calculate mean concentrations.

\* = Selected as a COPC.

**TABLE 3-8**  
**SUMMARY OF CHEMICALS DETECTED IN OU3 SUBSURFACE SOIL**  
**PCBs AREA**  
**(Concentrations in mg/kg)**

Chemical	Frequency of Detection (a)	Arithmetic Mean (b)	Range of Detection Limits	Range of Detected Concentrations	Industrial Soil RBC (c)	Maximum Detected > RBC?	Range of Background Concentrations (d)	Site > Background? (e)
<b>PCBs Area</b>								
<b>Organics:</b>								
PCB-1260	1 / 10	0.0239	0.0130	0.181	0.74	No	ND	---
<b>Inorganics:</b>								
Aluminum	9 / 9	8,360	NU	3,740 - 14,300	100,000	No	5,945 - 18,200	---
Barium	5 / 10	51.0	40.0	52.7 - 112	14,000	No	67.4 - 73.8	---
Beryllium	8 / 10	0.569	0.200	0.180 - 1.29	1.3	No	0.346 - 1.02	---
Calcium	2 / 3	817	100	1,030 - 1,370	4,000,000	No	113 - 454	---
Chromium	10 / 10	16.2	NU	5.63 - 30.3	1,000	No	3.66 - 25.0	---
Cobalt	8 / 10	7.62	2.0	3.22 - 27.8	12,000	No	4.56 - 13.9	---
Copper	8 / 8	12.7	NU	4.43 - 32.1	8,200	No	1.52 - 16.9	---
Iron	7 / 7	12,200	NU	5,830 - 19,600	61,000	No	2,490 - 27,800	---
Lead	4 / 10	6.91	7.50	10.1 - 13.6	400	No	7.38 - 11.8	---
Magnesium	8 / 8	1,780	NU	749 - 3,950	800,000	No	366 - 3,700	---
Manganese	3 / 3	234	NU	151 - 363	4,700	No	32.8 - 617	---
Nickel	9 / 10	9.78	2.0	2.52 - 36.0	4,100	No	4.40 - 17.9	---
Potassium	1 / 1	NC	NU	844	1,000,000	No	148 - 624	---
Selenium	1 / 10	6.13	10.0	16.3	1,000	No	16.1	---
Sodium	2 / 2	570	NU	439 - 701	1,000,000	No	320 - 933	---
Vanadium	7 / 7	39.6	NU	16.6 - 63.4	1,400	No	6.90 - 25.8	---
Zinc	6 / 6	40.1	NU	24.8 - 103	61,000	No	5.45 - 46.3	---

- (a) The number of samples in which the chemical was detected divided by the total number of samples analyzed, excluding samples rejected as a result of data validation.
- (b) Calculated by averaging the detected concentration(s) with one-half the detection limit of non-detected sample(s).
- (c) See Table 3-1 for a list of all industrial soil RBCs. Calcium, magnesium, potassium, and sodium are essential nutrients and do not have RBCs. Maximum concentrations of these chemicals were compared to allowable daily intake (ADI) levels.
- (d) Background concentrations are from samples MW-52 through MW-54, each at two depths.
- (e) Statistical comparisons to background were performed only for inorganics that exceed respective RBCs or ADIs.
- ND = Not detected.
- NU = Not used. The chemical was detected in all samples, thus detection limits were not used to calculate mean concentrations.

TABLE 3-9

## SUMMARY OF CHEMICALS OF POTENTIAL CONCERN AT OU3

CHEMICAL	SEDIMENT		SURFACE WATER			FISH	GROUNDWATER	SURFACE SOIL	SUBSURFACE SOIL
	PCBs Area	Pesticides Area	PCBs Area	Pesticides Area					
Organic Chemicals									
Benzo(a)anthracene								X	
Benzo(a)pyrene	X	X						X	
Benzo(b)fluoranthene								X	
delta-BHC						X			
gamma-Chlordane						X			
DDD						X			
DDE						X			
Dibenz(a,h)anthracene								X	
Dieldrin							X		
Indeno(1,2,3-c,d)pyrene								X	
PCB-1260	X					X		X	
Inorganic Chemicals									
Aluminum	b	b	X	X				b	
Arsenic							b	b	
Beryllium	b	b						b	
Iron	b	b	X	X			X	b	
Manganese	b	b	b	X			X	b	
Mercury						X			
Vanadium	b	b		X					

X = Selected as a COPC.

b = Inorganic chemical within background levels, but above residential soil RBCs (for surface soil and sediment), industrial soil RBCs (for subsurface soil), or tap water RBCs (for groundwater and surface water).

TABLE 3-10

## POTENTIAL HUMAN EXPOSURE PATHWAYS UNDER CURRENT LAND-USE CONDITIONS AT OU3

Exposure Medium	Potential Receptor	Exposure Route	Pathway Potentially Complete? Basis.	Method of Evaluation
Sediment	Security guards, on-site workers	<ul style="list-style-type: none"> <li>Incidental ingestion</li> <li>Dermal contact</li> </ul>	No. These receptors would not be likely to contact sediment from the PCBs and Pesticides Areas under current land-use conditions, thus exposures to COPCs in sediment would not be likely to occur.	None.
	Trespassers/recreational users, environmental educators	<ul style="list-style-type: none"> <li>Incidental ingestion</li> <li>Dermal contact</li> </ul>	Yes. Because these areas are not restricted, trespassers, recreational users, and environmental educators could come into contact with COPCs in sediment from the PCBs and Pesticides Areas. However, exposures to environmental educators are limited under current land-use conditions.	Quantitative for incidental ingestion and dermal absorption for trespassers/recreational users.
Surface water	Security guards, on-site workers	<ul style="list-style-type: none"> <li>Incidental ingestion</li> <li>Dermal contact</li> </ul>	No. These receptors would not be likely to contact surface water from the PCBs and Pesticides Areas, thus exposures to COPCs in surface water would not be likely to occur.	None.
	Trespassers/recreational users, environmental educators	<ul style="list-style-type: none"> <li>Incidental ingestion</li> <li>Dermal contact</li> </ul>	Yes. Trespassers, recreational users, and environmental educators could come into contact with COPCs in surface water from the PCBs and Pesticides Areas while wading or playing. However, exposures to environmental educators are limited under current land-use conditions.	Quantitative for dermal absorption for trespassers/recreational users.
Fish	Workers, trespassers/recreational users	<ul style="list-style-type: none"> <li>Ingestion</li> </ul>	No. Fishing does not occur in the OU3 ditches; individuals fishing would more likely fish in better areas, such as along Marumco Creek or Occoquan Bay.	None.
Groundwater	Workers, trespassers/recreational users	<ul style="list-style-type: none"> <li>Ingestion</li> </ul>	No. Groundwater is not used for any purpose at WRF, thus exposures to groundwater do not occur.	None.
Surface soil	On-site workers, environmental educators	<ul style="list-style-type: none"> <li>Incidental ingestion</li> <li>Dermal contact</li> </ul>	Yes. Although workers could contact surface soil, their exposures would be limited under current land-use conditions, since they are not outdoors on a frequent basis. Exposures to environmental educators could occur, but are limited under current land-use conditions.	None.

**TABLE 3-10**  
**POTENTIAL HUMAN EXPOSURE PATHWAYS UNDER CURRENT LAND-USE CONDITIONS AT OU3 (continued)**

Exposure Medium	Potential Receptor	Exposure Route	Pathway Potentially Complete? Basis.	Method of Evaluation
Surface soil (cont.)	Trespassers/ recreational users	<ul style="list-style-type: none"> <li>• Incidental ingestion</li> <li>• Dermal contact</li> </ul>	Yes. Trespassers and recreational users could come into contact with COPCs in surface soil at OU3.	Quantitative for incidental ingestion and dermal absorption for trespassers/recreational users.



TABLE 3-11

## POTENTIAL HUMAN EXPOSURE PATHWAYS UNDER HYPOTHETICAL FUTURE LAND-USE CONDITIONS AT OU3

Exposure Medium	Potential Receptor	Exposure Route	Pathway Potentially Complete? Basis.	Method of Evaluation
Sediment	Workers	<ul style="list-style-type: none"> <li>Incidental ingestion</li> <li>Dermal contact</li> </ul>	Yes. COPCs are present in sediment from both the PCBs and Pesticides Areas, and future maintenance or construction workers could contact sediment and be exposed to COPCs via incidental ingestion and dermal absorption.	Quantitative for incidental ingestion and dermal absorption.
	Residents	<ul style="list-style-type: none"> <li>Incidental ingestion</li> <li>Dermal contact</li> </ul>	Yes. COPCs are present in sediment from the PCBs and Pesticides Areas, and hypothetical future child residents could contact sediment and be exposed to COPCs via incidental ingestion and dermal absorption.	Quantitative for incidental ingestion and dermal absorption.
	Environmental educators	<ul style="list-style-type: none"> <li>Incidental ingestion</li> <li>Dermal contact</li> </ul>	Yes. COPCs are present in sediment from the PCBs and Pesticides Areas, and environmental educators could contact sediment and be exposed to COPCs via incidental ingestion and dermal absorption while conducting environmental programs.	Quantitative for incidental ingestion and dermal absorption.
	Workers	<ul style="list-style-type: none"> <li>Dermal contact</li> </ul>	No. Workers would not be likely to contact surface water from the PCBs and Pesticides Areas, and any exposures that they may have would be of short duration and likely over a small body surface area.	None.
Surface water	Residents	<ul style="list-style-type: none"> <li>Dermal contact</li> </ul>	Yes. COPCs are present in surface water, and hypothetical future child residents could contact surface water from the PCBs and Pesticides Areas and be exposed to COPCs via dermal absorption while wading or playing.	Quantitative for dermal absorption.
	Environmental educators	<ul style="list-style-type: none"> <li>Dermal contact</li> </ul>	Yes. COPCs are present in surface water, and environmental educators could contact surface water from the PCBs and Pesticides Areas and be exposed to COPCs via dermal absorption while conducting educational programs.	Quantitative for dermal absorption.
	Workers	<ul style="list-style-type: none"> <li>Ingestion</li> </ul>	Yes. Although workers could feasibly fish in the OU3 ditches, it is quite unlikely that this would occur, since they would more likely fish in better areas, such as Marumsco Creek and Occoquan Bay.	None.
	Residents	<ul style="list-style-type: none"> <li>Ingestion</li> </ul>	Yes. COPCs were detected in fish caught from OU3, and although very unlikely, it is possible that future adult residents at OU3 could consume the fish they catch from the PCBs Area ditches.	Quantitative for ingestion.

TABLE 3-11

## POTENTIAL HUMAN EXPOSURE PATHWAYS UNDER HYPOTHETICAL FUTURE LAND-USE CONDITIONS AT OU3 (continued)

Exposure Medium	Potential Receptor	Exposure Route	Pathway Potentially Complete? Basis.	Method of Evaluation
Groundwater	Residents	<ul style="list-style-type: none"> <li>• Ingestion</li> <li>• Dermal contact</li> <li>• Inhalation</li> </ul>	Yes. Child and adult residents could be exposed to COPCs in groundwater used for drinking water or for bathing. VOCs were not selected as COPCs in groundwater, thus inhalation exposures while showering were not evaluated.	Quantitative for ingestion and dermal contact.
	Workers	<ul style="list-style-type: none"> <li>• Ingestion</li> <li>• Dermal contact</li> </ul>	Yes. Workers could be exposed to COPCs in groundwater that is used for drinking water. Due to the low exposure frequency and small surface area, dermal exposures to workers would be limited.	Quantitative for ingestion.
Soil	Residents	<ul style="list-style-type: none"> <li>• Ingestion</li> <li>• Dermal contact</li> </ul>	Yes. Child and adult residents could be exposed to COPCs in surface soil via incidental ingestion and dermal absorption while out in their yards.	Quantitative for ingestion and dermal contact.
	Workers	<ul style="list-style-type: none"> <li>• Ingestion</li> <li>• Dermal contact</li> </ul>	Yes. Workers could be exposed to COPCs in surface soil via incidental ingestion and dermal absorption while performing maintenance activities at OU3.	Quantitative for ingestion and dermal contact.
	Environmental Educators	<ul style="list-style-type: none"> <li>• Ingestion</li> <li>• Dermal contact</li> </ul>	Yes. Environmental educators could be exposed to COPCs in surface soil via incidental ingestion and dermal absorption while performing educational programs at OU3.	Quantitative for ingestion and dermal contact.

**TABLE 3-12**  
**EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN**  
**AT WOODBRIDGE RESEARCH FACILITY - OU3**

Chemical	Arithmetic Mean	Maximum Detected Concentration	95% UCL	Exposure Point Concentration
<b><u>SEDIMENT (mg/kg)</u></b>				
<b><u>PCBs Area</u></b>				
<b>Organics:</b>				
Benzo(a)pyrene	0.235	0.596	14.1	0.596 *
PCB-1260	2.26	6.04	34,500	6.04 *
<b>Inorganics:</b>				
b Aluminum	12,300	15,900	16,300	15,900 *
b Beryllium	1.44	2.44	2.19	2.19
b Iron	16,500	19,400	22,700	19,400 *
b Manganese	396	564	650	564 *
b Vanadium	42.6	57.9	56.2	56.2
<b><u>Pesticides Area</u></b>				
<b>Organics:</b>				
Benzo(a)pyrene	0.0494	0.109	0.29	0.109 *
<b>Inorganics:</b>				
b Aluminum	13,900	15,600	16,800	15,600 *
b Beryllium	1.22	1.93	2.01	1.93 *
b Iron	22,200	34,600	31,500	31,500
b Manganese	356	391	441	391 *
b Vanadium	51.9	68.8	63	63
<b><u>SURFACE WATER (µg/L)</u></b>				
<b><u>PCBs Area</u></b>				
<b>Inorganics:</b>				
Aluminum	12,400	13,200	13,600	13,200 *
Iron	9,900	10,800	11,300	10,800 *
b Manganese	238	318	324	318 *
<b><u>Pesticides Area</u></b>				
<b>Inorganics:</b>				
Aluminum	13,800	16,100	15,400	15,400
Iron	12,900	17,300	15,600	15,600
Manganese	499	624	689	624 *
Vanadium	27.0	30.1	29.3	29.3
<b><u>FISH FILLET TISSUE (µg/kg - wet organics; mg/kg - wet inorganics)</u></b>				
<b><u>Bass</u></b>				
<b>Organics:</b>				
DDD	16.4	24.4	22.7	22.7
DDE	13.6	19.3	17.7	17.7
PCB-1260	103	157	149	149
<b>Inorganics:</b>				
Mercury	0.101	0.107	0.106	0.106
<b><u>Carp</u></b>				
<b>Organics:</b>				
gamma Chlordane	1.67	4.0	1,230,000	4.0 *
DDD	33.5	67.2	18,000	67.2 *

**TABLE 3-12**  
**EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN**  
**AT WOODBRIDGE RESEARCH FACILITY - OU3**

Chemical	Arithmetic Mean	Maximum Detected Concentration	95% UCL	Exposure Point Concentration
DDE	22.6	35.3	207	35.3 *
PCB-1260	143	224	1,640	224 *
<b><u>Crappie</u></b>				
Organics:				
DDE	87.4	108	114	108 *
PCB-1260	736	853	892	853 *
Inorganics:				
Mercury	0.064	0.077	0.0725	0.0725
<b><u>Eel</u></b>				
Organics:				
delta BHC	6.13	15.2	502	15.2 *
DDD	95.7	281	1,010,000,000	281 *
DDE	102	223	293	223 *
PCB-1260	1,440	4,380	17,000	4,380 *
Inorganics:				
Mercury	0.0485	0.102	0.176	0.102 *
<b><u>Sunfish</u></b>				
Organics:				
DDE	3.68	10.6	26,500	10.6 *
PCB-1260	37.5	53.7	500	53.7 *
<b><u>White Perch</u></b>				
Organics:				
PCB-1260	12.4	22.1	20	20
Inorganics:				
Mercury	0.0940	0.107	0.105	0.105
<b><u>GROUNDWATER (µg/L)</u></b>				
<b><u>PCBs Area</u></b>				
Organics:				
Dieldrin	0.00293	0.0090	0.0034	0.0034
Inorganics:				
b Arsenic	1.67	5.0	3.25	3.25
Iron	8,750	18,000	588,000	18,000 *
Manganese	306	562	584	562 *
<b><u>SURFACE SOIL (mg/kg)</u></b>				
<b><u>PCBs Area</u></b>				
Organics:				
Benzo(a)anthracene	0.958	10.0	31.7	10.0 *
Benzo(a)pyrene	0.783	8.0	8.76	8.0 *
Benzo(b)fluoranthene	1.01	10.0	8.40	8.40
Dibenz(a,h)anthracene	0.129	0.740	14.2	0.740 *
Indeno(1,2,3-c,d)pyrene	0.290	2.60	0.769	0.769
PCB-1260	0.178	0.702	1.69	0.702 *

**TABLE 3-12**  
**EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN**  
**AT WOODBRIDGE RESEARCH FACILITY - OU3**

Chemical	Arithmetic Mean	Maximum Detected Concentration	95% UCL	Exposure Point Concentration
<b>Inorganics:</b>				
b Aluminum	6,160	10,900	35,800	10,900 *
b Arsenic	3.26	4.30	4.04	4.04
b Beryllium	0.505	0.976	1.06	0.976 *
b Iron	9,430	16,500	36,700	16,500 *
b Manganese	387	788	1,220	788 *

(a) The units for the organic compounds were converted from ug/kg to mg/kg for use in calculating potential risks.

b = Chemical was detected at concentrations above its RBC or ADI, but within background concentrations and was evaluated separately from site-related chemicals.

NC = Not calculated because of low sample size.

\* = Indicates RME concentration is the maximum detected concentration.

TABLE 3-13

EXPOSURE PARAMETERS FOR INCIDENTAL INGESTION OF CHEMICALS IN SEDIMENT AND SURFACE SOIL  
BY TRESPASSERS/RECREATIONAL USERS AT OU3  
[CURRENT LAND-USE CONDITIONS]

$$(L)ADD_{pot} = \frac{C_s * IR * EF * ED * Bio * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Potential (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>pot</sub>	--	--
Chemical Concentration in Sediment or Soil (mg/kg)	C <sub>s</sub>	See Table 3-12	--
Ingestion Rate (mg/day)	IR	100	EPA 1991a
Exposure Frequency (days/year)	EF	50	Assumed
Exposure Duration (years)	ED	10	Assumed
Bioavailability Factor (unitless)	Bio	1.0	Assumed
Conversion Factor	CF	kg/10 <sup>6</sup> mg	--
Body Weight (kg)	BW	45	EPA 1985b
Averaging time (years) Carcinogens	AT	70	EPA 1991a
Noncarcinogens		10	EPA 1991a
Conversion Factor (days/year)	Days	365	--

TABLE 3-14

**EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF CHEMICALS IN SEDIMENT OR SOIL  
BY TRESPASSERS/RECREATIONAL USERS AT OU3  
[CURRENT LAND-USE CONDITIONS]**

$$(L)ADD_{int} = \frac{C_s * SA * AF * Ab * EF * ED * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Internal (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>int</sub>	--	--
Chemical Concentration in Sediment or Soil (mg/kg)	C <sub>s</sub>	See Table 3-12	--
Skin Surface Area Available for Contact (cm <sup>2</sup> )	SA	4,600	EPA 1985b
Soil-to-Skin Adherence Factor (mg/cm <sup>2</sup> -day)	AF	1.0	EPA 1992b
Dermal Absorption Factor (percent)	Ab		EPA 1995c
PAHs		10	
PCBs		6	
Inorganics		1	
Exposure Frequency (days/year)	EF	50	Assumed
Exposure Duration (years)	ED	10	Assumed
Conversion Factor	CF	kg/10 <sup>6</sup> mg	--
Body Weight (kg)	BW	45	EPA 1985b
Averaging time (years)	AT		
Carcinogens		70	EPA 1991a
Noncarcinogens		10	EPA 1991a
Conversion Factor (days/year)	Days	365	--

TABLE 3-15

**EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF CHEMICALS IN SURFACE WATER WHILE WADING  
BY TRESPASSERS/RECREATIONAL USERS AT OU3  
[CURRENT LAND-USE CONDITIONS]**

$$(L)ADD_{int} = \frac{DA * SA * EV * EF * ED}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Internal (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>int</sub>	--	--
Dose Absorbed Per Unit Area Per Event (mg/cm <sup>2</sup> -event)	DA	Calculated value	--
Skin Surface Area Available for Contact (cm <sup>2</sup> )	SA	4,600	EPA 1985b
Event Frequency (events/day)	EV	1	Assumed
Exposure Frequency (days/year)	EF	50	Assumed
Exposure Duration (years)	ED	10	Assumed
Body Weight (kg)	BW	45	EPA 1985b
Averaging time (years) Carcinogens Noncarcinogens	AT	70 10	EPA 1991a EPA 1991a
Conversion Factor (days/year)	Days	365	--



TABLE 3-16

EXPOSURE PARAMETERS FOR INCIDENTAL INGESTION OF CHEMICALS IN SEDIMENT BY WORKERS AT OU3  
[FUTURE LAND-USE CONDITIONS]

$$(L)ADD_{pot} = \frac{C_s * IR * EF * ED * Bio * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Potential (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>pot</sub>	--	--
Chemical Concentration in Sediment (mg/kg)	C <sub>s</sub>	See Table 3-12	--
Ingestion Rate (mg/day)	IR	480	EPA 1991a
Exposure Frequency (days/year)	EF	50	Assumed
Exposure Duration (years)	ED	1	Assumed
Bioavailability Factor (unitless)	Bio	1.0	Assumed
Conversion Factor	CF	kg/10 <sup>6</sup> mg	--
Body Weight (kg)	BW	70	EPA 1991a
Averaging time (years) Carcinogens	AT	70	EPA 1991a
Noncarcinogens		1	EPA 1991a
Conversion Factor (days/year)	Days	365	--

TABLE 3-17

**EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF CHEMICALS IN SEDIMENT BY WORKERS AT OU3**  
**[FUTURE LAND-USE CONDITIONS]**

$$(L)ADD_{int} = \frac{C_s * SA * AF * Ab * EF * ED * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Internal (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>int</sub>	--	--
Chemical Concentration in Sediment (mg/kg)	C <sub>s</sub>	See Table 3-12	--
Skin Surface Area Available for Contact (cm <sup>2</sup> )	SA	3,500	EPA 1985b
Soil-to-Skin Adherence Factor (mg/cm <sup>2</sup> -day)	AF	1.0	EPA 1992b
Dermal Absorption Factor (dimensionless)	Ab	10	EPA 1995c
PAHs		6	
PCBs		1	
Inorganics			
Exposure Frequency (days/year)	EF	50	Assumed
Exposure Duration (years)	ED	1	Assumed
Conversion Factor	CF	kg/10 <sup>6</sup> mg	--
Body Weight (kg)	BW	70	EPA 1991a
Averaging time (years)	AT		
Carcinogens		70	EPA 1991a
Noncarcinogens		1	EPA 1991a
Conversion Factor (days/year)	Days	365	--

TABLE 3-18

EXPOSURE PARAMETERS FOR INCIDENTAL INGESTION OF CHEMICALS IN SEDIMENT AND SOIL BY ENVIRONMENTAL EDUCATORS AT OU3  
[FUTURE LAND-USE CONDITIONS]

$$(L)ADD_{pot} = \frac{C_s * IR * EF * ED * Bio * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Potential (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>pot</sub>	--	--
Chemical Concentration in Sediment or Soil (mg/kg)	C <sub>s</sub>	See Table 3-12	--
Ingestion Rate (mg/day)	IR	100	EPA 1991a
Exposure Frequency (days/year)	EF	250	EPA 1991a
Exposure Duration (years)	ED	25	EPA 1991a
Bioavailability Factor (unitless)	Bio	1.0	Assumed
Conversion Factor	CF	kg/10 <sup>6</sup> mg	--
Body Weight (kg)	BW	70	EPA 1991a
Averaging time (years) Carcinogens	AT	70	EPA 1991a
Noncarcinogens		25	EPA 1991a
Conversion Factor (days/year)	Days	365	--

TABLE 3-19

EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF CHEMICALS IN SEDIMENT OR SOIL BY ENVIRONMENTAL EDUCATORS AT OU3  
[FUTURE LAND-USE CONDITIONS]

$$(L)ADD_{int} = \frac{C_s * SA * AF * Ab * EF * ED * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Internal (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>int</sub>	--	--
Chemical Concentration in Sediment (mg/kg)	C <sub>s</sub>	See Table 3-12	--
Skin Surface Area Available for Contact (cm <sup>2</sup> )	SA	3,500	EPA 1985b
Soil-to-Skin Adherence Factor (mg/cm <sup>2</sup> -day)	AF	1.0	EPA 1992b
Dermal Absorption Factor (dimensionless)	Ab	10	EPA 1995c
PAHs		6	
PCBs		1	
Inorganics			
Exposure Frequency (days/year)	EF	250	EPA 1991a
Exposure Duration (years)	ED	25	EPA 1991a
Conversion Factor	CF	kg/10 <sup>6</sup> mg	--
Body Weight (kg)	BW	70	EPA 1991a
Averaging time (years)	AT		
Carcinogens		70	EPA 1991a
Noncarcinogens		25	EPA 1991a
Conversion Factor (days/year)	Days	365	--

TABLE 3-20

EXPOSURE PARAMETERS FOR INCIDENTAL INGESTION OF CHEMICALS IN SEDIMENT BY CHILD RESIDENTS AT OU3  
[FUTURE LAND-USE CONDITIONS]

$$(L)ADD_{pot} = \frac{C_s * IR * EF * ED * Bio * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Potential (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>pot</sub>	--	--
Chemical Concentration in Sediment (mg/kg)	C <sub>s</sub>	See Table 3-12	--
Ingestion Rate (mg/day)	IR	200	EPA 1991a
Exposure Frequency (days/year)	EF	100	Assumed
Exposure Duration (years)	ED	6	EPA 1991a
Bioavailability Factor (unitless)	Bio	1.0	Assumed
Conversion Factor	CF	kg/10 <sup>6</sup> mg	--
Body Weight (kg)	BW	15	EPA 1991a
Averaging time (years) Carcinogens	AT	70	EPA 1991a
Noncarcinogens		6	EPA 1991a
Conversion Factor (days/year)	Days	365	--

TABLE 3-21

EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF CHEMICALS IN SEDIMENT BY CHILD RESIDENTS AT OU3  
[FUTURE LAND-USE CONDITIONS]

$$(L)ADD_{int} = \frac{C_s * SA * AF * Ab * EF * ED * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Internal (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>int</sub>	--	--
Chemical Concentration in Sediment (mg/kg)	C <sub>s</sub>	See Table 3-12	--
Skin Surface Area Available for Contact (cm <sup>2</sup> )	SA	2,200	EPA 1985b
Soil-to-Skin Adherence Factor (mg/cm <sup>2</sup> -day)	AF	1.0	EPA 1992b
Dermal Absorption Factor (percent)	Ab		EPA 1995c
PAHs		10	
PCBs		6	
Inorganics		1	
Exposure Frequency (days/year)	EF	100	Assumed
Exposure Duration (years)	ED	6	EPA 1991a
Conversion Factor	CF	kg/10 <sup>6</sup> mg	--
Body Weight (kg)	BW	15	EPA 1991a
Averaging time (years)	AT		
Carcinogens		70	EPA 1991a
Noncarcinogens		6	EPA 1991a
Conversion Factor (days/year)	Days	365	--

TABLE 3-22

EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF CHEMICALS IN SURFACE WATER BY ENVIRONMENTAL EDUCATORS AT OU3  
[FUTURE LAND-USE CONDITIONS]

$$(L)ADD_{Int} = \frac{DA * SA * EV * EF * ED}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Internal (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>Int</sub>	--	--
Dose Absorbed Per Unit Area Per Event (mg/cm <sup>2</sup> -event)	DA	Calculated value	--
Skin Surface Area Available for Contact (cm <sup>2</sup> )	SA	3,500	EPA 1985b
Event Frequency (events/day)	EV	1	Assumed
Exposure Frequency (days/year)	EF	100	Assumed
Exposure Duration (years)	ED	25	EPA 1991a
Body Weight (kg)	BW	70	EPA 1991a
Averaging time (years) Carcinogens	AT	70	EPA 1991a
Noncarcinogens		25	EPA 1991a
Conversion Factor (days/year)	Days	365	--

TABLE 3-23

EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF CHEMICALS IN SURFACE WATER WHILE WADING BY CHILD RESIDENTS AT OU3  
[FUTURE LAND-USE CONDITIONS]

$$(L)ADD_{int} = \frac{DA * SA * EV * EF * ED}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Internal (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>int</sub>	--	--
Dose Absorbed Per Unit Area Per Event (mg/cm <sup>2</sup> -event)	DA	Calculated value	--
Skin Surface Area Available for Contact (cm <sup>2</sup> )	SA	2,200	EPA 1985b
Event Frequency (events/day)	EV	1	Assumed
Exposure Frequency (days/year)	EF	100	Assumed
Exposure Duration (years)	ED	6	EPA 1991a
Body Weight (kg)	BW	15	EPA 1991a
Averaging time (years) Carcinogens	AT	70	EPA 1991a
Noncarcinogens		6	EPA 1991a
Conversion Factor (days/year)	Days	365	--



TABLE 3-24

EXPOSURE PARAMETERS FOR INGESTION OF CHEMICALS IN FISH BY ADULT RESIDENTS AT OU3  
[FUTURE LAND-USE CONDITIONS]

$$(L)ADD_{pot} = \frac{C_{fish} * IR * EF * ED * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Potential (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>pot</sub>	--	--
Chemical Concentration in Fish (mg/kg)	C <sub>fish</sub>	See Table 3-12	--
Ingestion Rate (g/day)	IR	54	EPA 1991a
Exposure Frequency (days/year)	EF	175	EPA 1991a
Exposure Duration (years)	ED	30	EPA 1991a
Conversion Factor	CF	mg/10 <sup>3</sup> µg	--
Body Weight (kg)	BW	70	EPA 1991a
Averaging time (years)	AT	70	EPA 1991a
Carcinogens		30	EPA 1991a
Noncarcinogens			
Conversion Factor (days/year)	Days	365	--

TABLE 3-25

EXPOSURE PARAMETERS FOR INCIDENTAL INGESTION OF CHEMICALS IN SOIL BY WORKERS AT OU3  
[FUTURE LAND-USE CONDITIONS]

$$(L)ADD_{pot} = \frac{C_s * IR * EF * ED * Bio * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Potential (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>pot</sub>	--	--
Chemical Concentration in Soil (mg/kg)	C <sub>s</sub>	See Table 3-12	--
Ingestion Rate (mg/day)	IR	50	EPA 1991a
Exposure Frequency (days/year)	EF	250	EPA 1991a
Exposure Duration (years)	ED	25	EPA 1991a
Bioavailability Factor (unitless)	Bio	1.0	Assumed
Conversion Factor	CF	kg/10 <sup>6</sup> mg	--
Body Weight (kg)	BW	70	EPA 1991a
Averaging time (years) Carcinogens	AT	70	EPA 1991a
Noncarcinogens		25	EPA 1991a
Conversion Factor (days/year)	Days	365	--

TABLE 3-26

**EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF CHEMICALS IN SOIL BY WORKERS AT OU3  
[FUTURE LAND-USE CONDITIONS]**

$$(L)ADD_{int} = \frac{C_s * SA * AF * Ab * EF * ED * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Internal (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>int</sub>	--	--
Chemical Concentration in Soil (mg/kg)	C <sub>s</sub>	See Table 3-12	--
Skin Surface Area Available for Contact (cm <sup>2</sup> )	SA	3,500	EPA 1985b
Soil-to-Skin Adherence Factor (mg/cm <sup>2</sup> -day)	AF	1.0	EPA 1992b
Dermal Absorption Factor (dimensionless)	Ab	10	EPA 1995c
		6	
Exposure Frequency (days/year)	EF	250	Assumed
Exposure Duration (years)	ED	25	Assumed
Conversion Factor	CF	kg/10 <sup>6</sup> mg	--
Body Weight (kg)	BW	70	EPA 1991a
Averaging time (years)	AT		
Carcinogens		70	EPA 1991a
Noncarcinogens		25	EPA 1991a
Conversion Factor (days/year)	Days	365	--

TABLE 3-27

**EXPOSURE PARAMETERS FOR INCIDENTAL INGESTION OF CHEMICALS IN SURFACE SOIL BY RESIDENTS AT OU3  
[FUTURE LAND-USE CONDITIONS]**

$$(L)ADD_{pot} = \frac{C_s * IR * EF * ED * Bio * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case		
		Child	Adult	Source
Potential (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>pot</sub>	--	--	--
Chemical Concentration in Surface Soil (mg/kg)	C <sub>s</sub>	--	--	--
Ingestion Rate (mg/day)	IR	200	100	EPA 1991a
Exposure Frequency (days/year)	EF	350	350	EPA 1991a
Exposure Duration (years)	ED	6	30	EPA 1991a
Bioavailability Factor (unitless)	Bio	1.0	1.0	Assumed
Conversion Factor	CF	kg/10 <sup>6</sup> mg	kg/10 <sup>6</sup> mg	--
Body Weight (kg)	BW	15	70	EPA 1991a
Averaging time (years) Carcinogens	AT	70	70	EPA 1991a
Noncarcinogens		6	30	EPA 1991a
Conversion Factor (days/year)	Days	365	365	--

TABLE 3-28

**EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF CHEMICALS IN SURFACE SOIL BY RESIDENTS AT OU3**  
**[FUTURE LAND-USE CONDITIONS]**

$$(L)ADD_{int} = \frac{C_s * SA * AF * Ab * EF * ED * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case			Source
		Child	Adult		
Internal (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>int</sub>	--	--		--
Chemical Concentration in Surface Soil (mg/kg)	C <sub>s</sub>	--	--		--
Skin Surface Area Available for Contact (cm <sup>2</sup> ) (a)	SA	2,200	6,400		EPA 1985
Soil-to-Skin Adherence Factor (mg/cm <sup>2</sup> -day)	AF	1.0	1.0		EPA 1992b
Dermal Absorption Factor (percent)	Ab				
PAHs		10	10		EPA 1995c
PCBs		6	6		
Exposure Frequency (days/year)	EF	350	350		EPA 1991a
Exposure Duration (years)	ED	6	30		EPA 1991a
Conversion Factor	CF	kg/10 <sup>6</sup> mg	kg/10 <sup>6</sup> mg		--
Body Weight (kg)	BW	15	70		EPA 1991a
Averaging time (years)	AT				
Carcinogens		70	70		EPA 1991a
Noncarcinogens		6	30		EPA 1991a
Conversion Factor (days/year)	Days	365	365		--

(a) The values for surface area assumed that ½ arms, ½ legs, feet, and hands are available for exposures.

TABLE 3-29

EXPOSURE PARAMETERS FOR INGESTION OF CHEMICALS IN GROUNDWATER BY RESIDENTS AT OU3  
[FUTURE LAND-USE CONDITIONS]

$$(L)ADD_{pot} = \frac{C_{gw} * IR * EF * ED * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case		
		Child	Adult	Source
Potential (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>pot</sub>	--	--	--
Chemical Concentration in Groundwater (µg/L)	C <sub>gw</sub>	--	--	--
Ingestion Rate (L/day)	IR	1	2	EPA 1991a
Exposure Frequency (days/year)	EF	350	350	EPA 1991a
Exposure Duration (years)	ED	6	30	EPA 1991a
Conversion Factor	CF	mg/10 <sup>3</sup> µg	mg/10 <sup>3</sup> µg	--
Body Weight (kg)	BW	15	70	EPA 1991a
Averaging time (years)	AT	70	70	EPA 1991a
Carcinogens		6	30	EPA 1991a
Noncarcinogens				
Conversion Factor (days/year)	Days	365	365	--

TABLE 3-30

EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF CHEMICALS IN GROUNDWATER WHILE BATHING BY RESIDENTS AT OU2 AND OU4  
[FUTURE LAND-USE CONDITIONS]

$$(L)ADD_{int} = \frac{DA * SA * EV * EF * ED}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case			Source
		Child	Adult	Case	
Internal (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>int</sub>	--	--	--	--
Dose Absorbed Per Unit Area Per Event (mg/cm <sup>2</sup> -event) (a)	DA	Calculated Value	Calculated Value	--	--
Skin Surface Area Available for Contact (cm <sup>2</sup> ) (b)	SA	7,000	18,000	EPA 1985b	
Event Frequency (events/day)	EV	1	1	Assumed	
Exposure Frequency (days/year)	EF	350	350	EPA 1991a	
Exposure Duration (years)	ED	6	30	EPA 1991a	
Body Weight (kg)	BW	15	70	EPA 1991a	
Averaging time (years)	AT				
Carcinogens		70	70	EPA 1991a	
Noncarcinogens		6	30	EPA 1991a	
Conversion Factor (days/year)	Days	365	365	--	--

(a) See text for equations on the derivation of the DA value.

(b) The values for surface area assumed that the entire body is available for exposure.

TABLE 3-31

## PARAMETERS FOR EVALUATING THE DERMAL PATHWAY (a)

Chemical	Kp (b) (cm/hr)	MW (g/mol)	Log K <sub>ow</sub> (---)	B (---)	Dsc (cm <sup>2</sup> /hr)	Tau (hr)	t* Used
<b>Organics</b>							
Dieldrin	0.016	381	4.56	3.63	9.04E-09	18.4	93.8
<b>Inorganics</b>							
Aluminum	0.001	NU	NU	NU	NU	NU	NU
Iron	0.001	NU	NU	NU	NU	NU	NU
Manganese	0.001	NU	NU	NU	NU	NU	NU
Vanadium	0.001	NU	NU	NU	NU	NU	NU

(a) Only chemicals that were evaluated for the dermal pathways for surface water and groundwater are presented on this table.

(b) Kp values were estimated, using the chemical's molecular weight and log Kow (USEPA 1992b), using the chemical's molecular weight and log Kow (USEPA 1992b), except where noted.

(c) The Kp for chloroform is a measure value from USEPA (1992b).

NU = Parameter not used for this chemical.



TABLE 3-32

EXPOSURE PARAMETERS FOR INGESTION OF CHEMICALS IN GROUNDWATER BY WORKERS AT OU3  
[FUTURE LAND-USE CONDITIONS]

$$(L)ADD_{pot} = \frac{C_s * IR * EF * ED * Bio * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Reasonable Maximum Exposure (RME) Case	Source
Potential (Lifetime) Average Daily Dose (mg/kg-day)	(L)ADD <sub>pot</sub>	--	--
Chemical Concentration in Groundwater (µg/L)	C <sub>gw</sub>	See Table 3-12	--
Ingestion Rate (L/day)	IR	1	EPA 1991a
Exposure Frequency (days/year)	EF	250	EPA 1991a
Exposure Duration (years)	ED	25	EPA 1991a
Conversion Factor	CF	mg/10 <sup>3</sup> µg	--
Body Weight (kg)	BW	70	EPA 1991a
Averaging time (years) Carcinogens	AT	70	EPA 1991a
Noncarcinogens		25	EPA 1991a
Conversion Factor (days/year)	Days	365	--

TABLE 3-33

## CHRONIC ORAL TOXICITY CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN AT OU3

Chemical	Toxicity Criteria For Carcinogenic Effects			Toxicity Criteria for Noncarcinogenic Effects			
	Oral Slope Factor (mg/kg-day) <sup>-1</sup>	Weight-of-Evidence Classification (a)	Slope Factor Source	Chronic Oral Reference Dose (RfD) (mg/kg-day)	Uncertainty Factor (b)	Target Organ/Critical Effect (c)	RfD Source
Organics:							
Benzo(a)anthracene	7.3E-01 (d)	B2	IRIS	---	---	---	---
Benzo(a)pyrene	7.3E+00	B2	IRIS	---	---	---	---
Benzo(b)fluoranthene	7.3E-01 (d)	B2	IRIS	---	---	---	---
delta-BHC	---	D	IRIS	---	---	---	---
gamma-Chlordane (e)	1.3E+00	B2	IRIS	6E-05	1,000	Liver	IRIS
DDD	2.4E-01	B2	IRIS	---	---	---	---
DDE	3.4E-01	B2	IRIS	---	---	---	---
Dibenzo(a,h)anthracene	7.3E+00 (d)	B2	IRIS	---	---	---	---
Dieldrin	1.6E+01	B2	IRIS	5E-05	100	Liver	IRIS
Indeno(1,2,3-c,d)pyrene	7.3E-01 (d)	B2	IRIS	---	---	---	---
PCB-1260 (f)	2.0E+00	B2	IRIS	---	---	---	---
Inorganics:							
Aluminum	---	---	---	1E+00	---	---	NCEA
Beryllium	4.3E+00	B2	IRIS	5E-03	100	None observed	IRIS
Iron	---	---	---	3E-01	---	---	NCEA
Manganese	---	D	IRIS	2.4E-02	3	CNS	IRIS
Methyl mercury	---	D	IRIS	1E-04	---	CNS	IRIS
Vanadium	---	---	---	7E-03	100	None observed	HEAST

(a) USEPA weight-of-evidence classification scheme for carcinogens:

A = Human Carcinogen, sufficient evidence of carcinogenicity in humans;

B1 = Probable Human Carcinogen, limited human data are available;

B2 = Probable Human Carcinogen, sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans;

C = Possible Human Carcinogen, limited evidence from animal studies in the absence of human studies; and

D = Not classified as to human carcinogenicity, inadequate or no evidence.

(b) Uncertainty factors presented are the products of specific uncertainty factors and modifying factors. Uncertainty factors used to develop reference doses generally consist of multiples of 10, with each factor representing a specific area of uncertainty in the data available.

The standard uncertainty factors include:

- a 10-fold factor to account for the variation in sensitivity among the members of the human population;

- a 10-fold factor to account for the uncertainty in extrapolating animal data to the case of humans;

- a 10-fold factor to account for the uncertainty in extrapolating from less-than-chronic NOAELs to chronic NOAELs;

- a 10-fold factor to account for the uncertainty in extrapolating from LOAELs to NOAELs.

Modifying factors are applied at the discretion of the RfD reviewer to cover other uncertainties in the data and range from 1 to 10.

(c) A target organ or critical effect is the organ/effect most sensitive to the chemical exposure. RfDs are based on toxic effects in the target organ or critical effects. If an RfD is based on a study in which a target organ or critical effect was not identified, the organ/effect listed is one known to be affected by the chemical.

(d) The cancer slope factor for benzo(a)pyrene was used to evaluate carcinogenic PAHs, along with the toxic equivalency factor (TEF) approach. The TEFs used are as follows: benzo(a)anthracene, benzo(b)fluoranthene, and indeno(1,2,3-c,d)pyrene, 0.1; dibenzo(a,h)anthracene, 1.0.

(e) Toxicity criteria for chlordane was used.

(f) Because PCB-1260 is potentially carcinogenic and there is no evidence of it causing noncarcinogenic effects, only the toxicity criterion for carcinogenic effects of PCBs is presented.

--- = No information available.

CNS = Central Nervous System.

NOTE: IRIS = Integrated Risk Information System - EPA 1996.

HEAST = Health Effects Assessment Summary Tables - EPA 1995d.

NCEA = National Center for Environmental Assessment - These values were obtained from the USEPA Region III RBC table.

TABLE 3-34

**ADJUSTED CHRONIC ORAL TOXICITY CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN  
EVALUATED FOR THE DERMAL PATHWAYS**

Chemical	Absolute Oral Absorption Factor	Source of Absolute Oral Absorption Factor	Slope Factor (mg/kg-day) <sup>-1</sup>	Adjusted Slope Factor (mg/kg-day) <sup>-1</sup> (a)	Reference Dose (mg/kg-day)	Adjusted Reference Dose (mg/kg-day) (b)
<b>Organics:</b>						
Benzo(a)anthracene	1	Default value	7.3E-01	7.3E-01	---	---
Benzo(a)pyrene	1	Default value	7.3E+00	7.3E+00	---	---
Benzo(b)fluoranthene	1	Default value	7.3E-01	7.3E-01	---	---
Dibenz(a,h)anthracene	1	Default value	7.3E+00	7.3E+00	---	---
Indeno(1,2,3-c,d)pyrene	1	Default value	7.3E-01	7.3E-01	---	---
PCBs	0.93	ATSDR 1991a	2.0E+00	2.2E+00	---	---
<b>Inorganics:</b>						
Aluminum	1	Default value	---	---	1.0E+00	1.0E+00
Beryllium	0.005	ATSDR 1991b	4.3E+00	8.6E+02	5.0E-03	2.5E-05
Iron	1	Default value	---	---	3.0E-01	3.0E-01
Manganese	0.055	ATSDR 1990	---	---	2.4E-02	1.3E-03
Vanadium	0.03	ATSDR 1992	---	---	7.0E-03	2.1E-04

(a) Adjusted slope factors were calculated by dividing the slope factor by the absolute oral absorption factor.

(b) Adjusted reference doses were calculated by multiplying the reference dose by the absolute oral absorption factor.

**TABLE 3-35**  
**EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SEDIMENT**  
**BY TRESPASSERS/RECREATIONAL USERS AT OU3**

**CURRENT LAND-USE CONDITIONS**

<b>Carcinogenic Chemical</b>	<b>RME Exposure Point Concentration (mg/kg)</b>	<b>Lifetime Average Daily Dose (mg/kg-day)</b>	<b>Slope Factor (mg/kg-day)<sup>-1</sup></b>	<b>Weight-of-Evidence Classification</b>	<b>RME Excess Lifetime Cancer Risk</b>
<b>PCBs Area</b>					
Benzo(a)pyrene	0.596 *	2.59E-08	7.3E+00	B2	2E-07
PCB-1260	6.04 *	2.63E-07	2.0E+00	B2	5E-07
<b>Total:</b>					7E-07
<b>Pesticides Area</b>					
Benzo(a)pyrene	0.109 *	4.74E-09	7.3E+00	B2	3E-08
<b>Total:</b>					3E-08

\* Denotes maximum detected concentration.

**TABLE 3-36**  
**EXPOSURES AND RISKS ASSOCIATED WITH DERMAL ABSORPTION OF CHEMICALS IN**  
**SEDIMENT BY TRESPASSERS/RECREATIONAL USERS AT OU3**

**CURRENT LAND-USE CONDITIONS**

<b>Carcinogenic Chemical</b>	<b>RME Exposure Point Concentration (mg/kg)</b>	<b>Lifetime Average Daily Dose (mg/kg-day)</b>	<b>Adjusted Slope Factor (mg/kg-day)<sup>-1</sup></b>	<b>Weight-of- Evidence Classification</b>	<b>RME Excess Lifetime Cancer Risk</b>
<b>PCBs Area</b>					
Benzo(a)pyrene	0.596 *	1.19E-07	7.3E+00	B2	9E-07
PCB-1260	6.04 *	7.25E-07	2.2E+00	B2	2E-06
<b>Total:</b>					2E-06
<b>Pesticides Area</b>					
Benzo(a)pyrene	0.109 *	2.18E-08	7.3E+00	B2	2E-07
<b>Total:</b>					2E-07

\* Denotes maximum detected concentration.

**TABLE 3-37**  
**EXPOSURES AND RISKS ASSOCIATED WITH DERMAL ABSORPTION OF CHEMICALS IN**  
**SURFACE WATER BY TRESPASSERS/RECREATIONAL USERS AT OU3**

**CURRENT LAND-USE CONDITIONS**

Noncarcinogenic Chemical	RME Exposure Point Concentration (µg/L)	Average Daily Dose (mg/kg-day)	Adjusted RfD (mg/kg-day)	Target Organ/ Critical Effect	RME ADD:RfD Ratio
<b>PCBs Area</b>					
<b>Inorganics</b>					
Aluminum	13,200 *	3.70E-04	1E+00	---	4E-04
Iron	10,800 *	3.02E-04	3E-01	---	1E-03
<b>Hazard Index:</b>					1E-03
<b>Pesticides Area</b>					
<b>Inorganics</b>					
Aluminum	15,400	4.31E-04	1E+00	---	4E-04
Iron	15,600	4.37E-04	3E-01	---	1E-03
Manganese	624 *	1.75E-05	1E-03	CNS	1E-02
Vanadium	29.3	8.21E-07	2E-04	None observed	4E-03
<b>Hazard Index:</b>					2E-02

\* Maximum detected concentration.

CNS = Central Nervous System

**TABLE 3-38**  
**EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SURFACE SOIL**  
**BY TRESPASSERS/RECREATIONAL USERS AT OU3**

**CURRENT LAND-USE CONDITIONS**

	RME Exposure Point Concentration (mg/kg)	Lifetime Average Daily Dose (mg/kg-day)	Slope Factor (mg/kg-day) <sup>-1</sup>	Weight-of-Evidence Classification	RME Excess Lifetime Cancer Risk
Carcinogenic Chemical					
PCBS Area					
Organics					
Benzo(a)anthracene	10 *	4.35E-07	7.3E-01	B2	3E-07
Benzo(a)pyrene	8 *	3.48E-07	7.3E+00	B2	3E-06
Benzo(b)fluoranthene	8.4	3.65E-07	7.3E-01	B2	3E-07
Dibenz(a,h)anthracene	0.74 *	3.22E-08	7.3E+00	B2	2E-07
Indeno(1,2,3-c,d)pyrene	0.769	3.34E-08	7.3E-01	B2	2E-08
PCB-1260	0.702 *	3.05E-08	2.0E+00	B2	6E-08
Total:					3E-06

\* Maximum detected concentration.

**TABLE 3-39**  
**EXPOSURES AND RISKS ASSOCIATED WITH DERMAL ABSORPTION OF CHEMICALS IN SURFACE SOIL**  
**BY TRESPASSERS/RECREATIONAL USERS AT OU3**

**CURRENT LAND-USE CONDITIONS**

<b>Carcinogenic Chemical</b>	<b>RME Exposure Point Concentration (mg/kg)</b>	<b>Lifetime Average Daily Dose (mg/kg-day)</b>	<b>Adjusted Slope Factor (mg/kg-day)<sup>-1</sup></b>	<b>Weight-of-Evidence Classification</b>	<b>RME Excess Lifetime Cancer Risk</b>
<b>PCBs Area</b>					
<b>Organics</b>					
Benzo(a)anthracene	10 *	2.00E-06	7.3E-01	B2	1E-06
Benzo(a)pyrene	8 *	1.60E-06	7.3E+00	B2	1E-05
Benzo(b)fluoranthene	8.4	1.68E-06	7.3E-01	B2	1E-06
Dibenz(a,h)anthracene	0.74 *	1.48E-07	7.3E+00	B2	1E-06
Indeno(1,2,3-c,d)pyrene	0.769	1.54E-07	7.3E-01	B2	1E-07
PCB-1260	0.702 *	8.43E-08	2.2E+00	B2	2E-07
<b>Total:</b>					2E-05

\* Maximum detected value.



**TABLE 3-40**  
**EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SEDIMENT BY CHILD RESIDENTS AT OU3**  
**FUTURE LAND-USE CONDITIONS**

<b>Carcinogenic Chemical</b>	<b>RME Exposure Point Concentration (mg/kg)</b>	<b>Lifetime Average Daily Dose (mg/kg-day)</b>	<b>Slope Factor (mg/kg-day)<sup>-1</sup></b>	<b>Weight-of-Evidence Classification</b>	<b>RME Lifetime Excess Cancer Risk</b>
<b>PCBs Area</b>					
Benzo(a)pyrene	0.596 *	1.87E-07	7.3E+00	B2	1E-06
PCB-1260	6.04 *	1.89E-06	2.0E+00	B2	4E-06
<b>Total:</b>					5E-06
<b>Pesticides Area</b>					
Benzo(a)pyrene	0.109 *	3.41E-08	7.3E+00	B2	2E-07
<b>Total:</b>					2E-07

\* Denotes maximum detected concentration.

**TABLE 3-41**  
**EXPOSURES AND RISKS ASSOCIATED WITH DERMAL ABSORPTION OF CHEMICALS IN**  
**SEDIMENT BY CHILD RESIDENTS AT OU3**

**FUTURE LAND-USE CONDITIONS**

<b>Carcinogenic Chemical</b>	<b>RME Exposure Point Concentration (mg/kg)</b>	<b>Lifetime Average Daily Dose (mg/kg-day)</b>	<b>Adjusted Slope Factor (mg/kg-day)<sup>-1</sup></b>	<b>Weight-of- Evidence Classification</b>	<b>RME Excess Lifetime Cancer Risk</b>
<b><u>PCBs Area</u></b>					
Benzo(a)pyrene	0.596 *	2.05E-07	7.3E+00	B2	1E-06
PCB-1260	6.04 *	1.25E-06	2.2E+00	B2	3E-06
<b>Total:</b>					4E-06
<b><u>Pesticides Area</u></b>					
Benzo(a)pyrene	0.109 *	3.75E-08	7.3E+00	B2	3E-07
<b>Total:</b>					3E-07

\* Denotes maximum detected concentration.

**TABLE 3-42**  
**EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SEDIMENT BY WORKERS AT OU3**  
**FUTURE LAND-USE CONDITIONS**

<b>Carcinogenic Chemical</b>	<b>RME Exposure Point Concentration (mg/kg)</b>	<b>Lifetime Average Daily Dose (mg/kg-day)</b>	<b>Slope Factor (mg/kg-day)<sup>-1</sup></b>	<b>Weight-of-Evidence Classification</b>	<b>RME Lifetime Excess Cancer Risk</b>
<b><u>PCBs Area</u></b>					
Benzo(a)pyrene	0.596 *	8.00E-09	7.3E+00	B2	6E-08
PCB-1260	6.04 *	8.11E-08	2.0E+00	B2	2E-07
<b>Total:</b>					2E-07
<b><u>Pesticides Area</u></b>					
Benzo(a)pyrene	0.109 *	1.46E-09	7.3E+00	B2	1E-08
<b>Total:</b>					1E-08

\* Denotes maximum detected concentration.

**TABLE 3-43**  
**EXPOSURES AND RISKS ASSOCIATED WITH DERMAL ABSORPTION OF CHEMICALS**  
**IN SEDIMENT BY WORKERS AT OU3**

**FUTURE LAND-USE CONDITIONS**

<b>Carcinogenic Chemical</b>	<b>RME Exposure Point Concentration (mg/kg)</b>	<b>Lifetime Average Daily Dose (mg/kg-day)</b>	<b>Adjusted Slope Factor (mg/kg-day)<sup>-1</sup></b>	<b>Weight-of- Evidence Classification</b>	<b>RME Excess Lifetime Cancer Risk</b>
<b><u>PCBs Area</u></b>					
Benzo(a)pyrene	0.596 *	5.83E-09	7.3E+00	B2	4E-08
PCB-1260	6.04 *	3.55E-08	2.2E+00	B2	8E-08
<b>Total:</b>					1E-07
<b><u>Pesticides Area</u></b>					
Benzo(a)pyrene	0.109 *	1.07E-09	7.3E+00	B2	8E-09
<b>Total:</b>					8E-09

\* Denotes maximum detected concentration.

**TABLE 3-44**  
**EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SEDIMENT**  
**BY ENVIRONMENTAL EDUCATORS AT OU3**

**FUTURE LAND-USE CONDITIONS**

<b>Carcinogenic Chemical</b>	<b>RME Exposure Point Concentration (mg/kg)</b>	<b>Lifetime Average Daily Dose (mg/kg-day)</b>	<b>Slope Factor (mg/kg-day)<sup>-1</sup></b>	<b>Weight-of-Evidence Classification</b>	<b>RME Lifetime Excess Cancer Risk</b>
<b>PCBs Area</b>					
Benzo(a)pyrene	0.596 *	2.08E-07	7.3E+00	B2	2E-06
PCB-1260	6.04 *	2.11E-06	2.0E+00	B2	4E-06
<b>Total:</b>					6E-06
<b>Pesticides Area</b>					
Benzo(a)pyrene	0.109 *	3.81E-08	7.3E+00	B2	3E-07
<b>Total:</b>					3E-07

\* Denotes maximum detected concentration.

**TABLE 3-45**  
**EXPOSURES AND RISKS ASSOCIATED WITH DERMAL ABSORPTION OF CHEMICALS IN**  
**SEDIMENT BY ENVIRONMENTAL EDUCATORS AT OU3**

**FUTURE LAND-USE CONDITIONS**

<b>Carcinogenic Chemical</b>	<b>RME Exposure Point Concentration (mg/kg)</b>	<b>Lifetime Average Daily Dose (mg/kg-day)</b>	<b>Adjusted Slope Factor (mg/kg-day)<sup>-1</sup></b>	<b>Weight-of- Evidence Classification</b>	<b>RME Excess Lifetime Cancer Risk</b>
<b><u>PCBs Area</u></b>					
Benzo(a)pyrene	0.596 *	7.29E-07	7.3E+00	B2	5E-06
PCB-1260	6.04 *	4.43E-06	2.2E+00	B2	1E-05
<b>Total:</b>					1E-05
<b><u>Pesticides Area</u></b>					
Benzo(a)pyrene	0.109 *	1.33E-07	7.3E+00	B2	1E-06
<b>Total:</b>					1E-06

\* Denotes maximum detected concentration.

**TABLE 3-46**  
**EXPOSURES AND RISKS ASSOCIATED WITH DERMAL ABSORPTION OF CHEMICALS IN**  
**SURFACE WATER BY CHILD RESIDENTS AT OU3**

**FUTURE LAND-USE CONDITIONS**

Noncarcinogenic Chemical	RME Exposure Point Concentration (µg/L)	Average Daily Dose (mg/kg-day)	Adjusted RfD (mg/kg-day)	Target Organ/ Critical Effect	RME ADD:RfD Ratio
<b>PCBs Area</b>					
<b>Inorganics</b>					
Aluminum	13,200 *	1.06E-03	1E+00	---	1E-03
Iron	10,800 *	8.68E-04	3E-01	---	3E-03
<b>Hazard Index:</b>					4E-03
<b>Pesticides Area</b>					
<b>Inorganics</b>					
Aluminum	15,400	1.24E-03	1E+00	---	1E-03
Iron	15,600	1.25E-03	3E-01	---	4E-03
Manganese	624 *	5.01E-05	1E-03	CNS	4E-02
Vanadium	29.3	2.35E-06	2E-04	None observed	1E-02
<b>Hazard Index:</b>					5E-02

\* Maximum detected concentration.

CNS = Central Nervous System

**TABLE 3-47**  
**EXPOSURES AND RISKS ASSOCIATED WITH DERMAL ABSORPTION OF CHEMICALS IN**  
**SURFACE WATER BY ENVIRONMENTAL EDUCATORS AT OU3**

**FUTURE LAND-USE CONDITIONS**

<b>Noncarcinogenic Chemical</b>	<b>RME Exposure Point Concentration (µg/L)</b>	<b>Average Daily Dose (mg/kg-day)</b>	<b>Adjusted RfD (mg/kg-day)</b>	<b>Target Organ/ Critical Effect</b>	<b>RME ADD:RfD Ratio</b>
<b>PCBs Area</b>					
<b>Inorganics</b>					
Aluminum	13,200 *	7.23E-04	1E+00	---	7E-04
Iron	10,800 *	5.92E-04	3E-01	---	2E-03
<b>Hazard Index:</b>					3E-03
<b>Pesticides Area</b>					
<b>Inorganics</b>					
Aluminum	15,400	8.44E-04	1E+00	---	8E-04
Iron	15,600	8.55E-04	3E-01	---	3E-03
Manganese	624 *	3.42E-05	1E-03	CNS	3E-02
Vanadium	29.3	1.61E-06	2E-04	None observed	8E-03
<b>Hazard Index:</b>					4E-02

\* Maximum detected concentration.

CNS = Central Nervous System



**TABLE 3-48**  
**EXPOSURES AND RISKS ASSOCIATED WITH INGESTION OF FISH BY ADULT RESIDENTS AT OU3**  
**FUTURE LAND-USE CONDITIONS**

Carcinogenic Chemical	RME Exposure Point Concentration (mg/kg)	Lifetime Average Daily Dose (mg/kg-day)	Slope Factor (mg/kg-day) <sup>-1</sup>	Weight-of-Evidence Classification	RME Lifetime Excess Cancer Risk
<b><u>Bass</u></b>					
DDD	0.023	3.60E-06	2.4E-01	B2	9E-07
DDE	0.018	2.81E-06	3.4E-01	B2	1E-06
PCB-1260	0.149	2.36E-05	7.7E+00	B2	2E-04
<b>Total:</b>					2E-04
<b><u>Carp</u></b>					
gamma-Chlordane	0.004 *	6.34E-07	1.3E+00	B2	8E-07
DDD	0.0672 *	1.07E-05	2.4E-01	B2	3E-06
DDE	0.0353 *	5.60E-06	3.4E-01	B2	2E-06
PCB-1260	0.224 *	3.55E-05	7.7E+00	B2	3E-04
<b>Total:</b>					3E-04
<b><u>Crappie</u></b>					
DDE	0.108 *	1.71E-05	3.4E-01	B2	6E-06
PCB-1260	0.853 *	1.35E-04	7.7E+00	B2	1E-03
<b>Total:</b>					1E-03
<b><u>Eel (a)</u></b>					
DDD	0.281 *	4.45E-05	2.4E-01	B2	1E-05
DDE	0.223 *	3.53E-05	3.4E-01	B2	1E-05
PCB-1260	4.38 *	6.94E-04	7.7E+00	B2	5E-03
<b>Total:</b>					5E-03
<b><u>Sunfish</u></b>					
DDE	0.0106 *	1.68E-06	3.4E-01	B2	6E-07
PCB-1260	0.0537 *	8.51E-06	7.7E+00	B2	7E-05
<b>Total:</b>					7E-05
<b><u>White Perch</u></b>					
PCB-1260	0.020	3.17E-06	7.7E+00	B2	2E-05
<b>Total:</b>					2E-05

Noncarcinogenic Chemical	RME Exposure Point Concentration (mg/kg)	Average Daily Dose (mg/kg-day)	RfD (mg/kg-day)	Target Organ/ Critical Effect	RME ADD:RfD Ratio
<b><u>Bass</u></b>					
Mercury	0.106	3.92E-05	1E-04	CNS	4E-01
<b>Hazard Index:</b>					4E-01
<b><u>Carp</u></b>					
gamma-Chlordane	0.004 *	1.48E-06	6E-05	Liver	2E-02
<b>Hazard Index:</b>					2E-02
<b><u>Crappie</u></b>					
Mercury	0.0725	2.68E-05	1E-04	CNS	3E-01
<b>Hazard Index:</b>					3E-01
<b><u>Eel</u></b>					
Mercury	0.102 *	3.77E-05	1E-04	CNS	4E-01
<b>Hazard Index:</b>					4E-01
<b><u>White Perch</u></b>					
Mercury	0.105	3.88E-05	1E-04	CNS	4E-01
<b>Hazard Index:</b>					4E-01

(a) delta-BHC was not evaluated due to a lack of toxicity criteria.

\* Maximum detected concentration.

CNS = Central Nervous System

**TABLE 3-49  
EXPOSURES AND RISKS ASSOCIATED WITH INGESTION OF GROUNDWATER  
BY HYPOTHETICAL FUTURE RESIDENTS AT OU3**

**FUTURE LAND-USE CONDITIONS**

Carcinogenic Chemical	RME Exposure Point Concentration (ug/L)	Lifetime Average Daily Dose (mg/kg-day)		Slope Factor (mg/kg-day) <sup>-1</sup>	Weight-of-Evidence Classification	RME Excess Lifetime Cancer Risk	
		Child	Adult			Child	Adult
<b>PCBs Area</b>							
Organics							
Dieldrin	0.0034	1.9E-08	4.0E-08	1.6E+01	B2	3E-07	6E-07
<b>Total:</b>						3E-07	6E-07
Noncarcinogenic Chemical	RME Exposure Point Concentration (ug/L)	Average Daily Dose (mg/kg-day)		RfD (mg/kg-day)	Target Organ/ Critical Effect	RME ADD:RfD Ratio	
		Child	Adult			Child	Adult
<b>PCBs Area</b>							
Organics							
Dieldrin	0.0034	2.2E-07	9.3E-08	5E-05	Liver	4E-03	2E-03
Inorganics							
Iron	18,000 *	1.2E+00	4.9E-01	3E-01	---	4E+00	2E+00
Manganese	562 *	3.6E-02	1.5E-02	2.4E-02	CNS	1E+00	6E-01
<b>Hazard Index:</b>						5E+00	2E+00

CNS = Central Nervous System.  
\* Maximum detected concentration.

**TABLE 3-50**  
**EXPOSURES AND RISKS ASSOCIATED WITH DERMAL ABSORPTION OF CHEMICALS IN GROUNDWATER**  
**BY HYPOTHETICAL FUTURE RESIDENTS AT OU3**

**FUTURE LAND-USE CONDITIONS**

Carcinogenic Chemical	RME	Lifetime Average Daily		Adjusted Slope Factor (mg/kg-day) <sup>-1</sup>	Weight-of-Evidence Classification	RME	
	Exposure Point	Dose				Excess Lifetime	
	Concentration (ug/L)	(mg/kg-day)				Cancer Risk	
		Child	Adult			Child	Adult
<u>PCBs Area</u>							
Organics							
Dieldrin	0.0034	1.3E-08	3.6E-08	1.6E+01	B2	2E-07	6E-07
Total:						2E-07	6E-07
Noncarcinogenic Chemical	RME	Average Daily Dose		Adjusted RfD (mg/kg-day)	Target Organ/ Critical Effect	RME	
	Exposure Point	(mg/kg-day)				ADD:RfD	
	Concentration (ug/L)	Child	Adult			Ratio	
		Child	Adult			Child	Adult
<u>PCBs Area</u>							
Organics							
Dieldrin	0.0034	1.5E-07	8.4E-08	5E-05	Liver	3E-03	2E-03
Inorganics							
Iron	18,000 *	2.3E-03	1.2E-03	3E-01	---	8E-03	4E-03
Manganese	562 *	7.0E-05	3.9E-05	1.3E-03	CNS	5E-02	3E-02
Hazard Index:						6E-02	4E-02

CNS = Central Nervous System.

\* Maximum Detected Concentration.

**TABLE 3-51  
EXPOSURES AND RISKS ASSOCIATED WITH INGESTION OF GROUNDWATER  
BY HYPOTHETICAL FUTURE WORKERS AT OU3**

**FUTURE LAND-USE CONDITIONS**

<b>Carcinogenic Chemical</b>	<b>RME Exposure Point Concentration (ug/L)</b>	<b>Lifetime Average Daily Dose (mg/kg-day)</b>	<b>Slope Factor (mg/kg-day)<sup>-1</sup></b>	<b>Weight-of-Evidence Classification</b>	<b>RME Excess Lifetime Cancer Risk</b>
<b>PCBs Area</b>					
<b>Organics</b>					
Dieldrin	0.0034	1.2E-08	1.6E+01	B2	2E-07
<b>Total:</b>					2E-07
<b>Noncarcinogenic Chemical</b>	<b>RME Exposure Point Concentration (ug/L)</b>	<b>Average Daily Dose (mg/kg-day)</b>	<b>RfD (mg/kg-day)</b>	<b>Target Organ/ Critical Effect</b>	<b>RME ADD:RfD Ratio</b>
<b>PCBs Area</b>					
<b>Organics</b>					
Dieldrin	0.0034	3.3E-08	5E-05	Liver	7E-04
<b>Inorganics</b>					
Iron	18,000 *	1.8E-01	3E-01	---	6E-01
Manganese	562 *	5.5E-03	2.4E-02	CNS	2E-01
<b>Hazard Index:</b>					8E-01

CNS = Central Nervous System.

\* Maximum detected concentration.

**TABLE 3-52**  
**EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SURFACE SOIL**  
**BY HYPOTHETICAL FUTURE RESIDENTS AT OU3**

**FUTURE LAND-USE CONDITIONS**

Carcinogenic Chemical	RME	Lifetime Average Daily Dose			Weight-of-Evidence Classification	RME	
	Exposure Point Concentration	(mg/kg-day)		Slope Factor (mg/kg-day) <sup>1</sup>		Excess Lifetime Cancer Risk	
	(mg/kg)	Child	Adult			Child	Adult
<b>PCBS Area</b>							
<b>Organics</b>							
Benzo(a)anthracene	10 *	1.10E-05	5.87E-06	7.3E-01	B2	8E-06	4E-06
Benzo(a)pyrene	8 *	8.77E-06	4.70E-06	7.3E+00	B2	6E-05	3E-05
Benzo(b)fluoranthene	8.4	9.21E-06	4.93E-06	7.3E-01	B2	7E-06	4E-06
Dibenz(a,h)anthracene	0.74 *	8.11E-07	4.34E-07	7.3E+00	B2	6E-06	3E-06
Indeno(1,2,3-c,d)pyrene	0.769	8.43E-07	4.51E-07	7.3E-01	B2	6E-07	3E-07
PCB-1260	0.702 *	7.69E-07	4.12E-07	2.0E+00	B2	2E-06	8E-07
Total:						9E-05	5E-05

\* Maximum detected concentration.

**TABLE 3-53**  
**EXPOSURES AND RISKS ASSOCIATED WITH DERMAL ABSORPTION OF CHEMICALS IN SURFACE SOIL**  
**BY HYPOTHETICAL FUTURE RESIDENTS AT OU3**

**FUTURE LAND-USE CONDITIONS**

Carcinogenic Chemical	RME	Lifetime Average Daily Dose		Adjusted Slope Factor (mg/kg-day) <sup>-1</sup>	Weight-of-Evidence Classification	RME	
	Exposure Point Concentration (mg/kg)	(mg/kg-day)				Excess Lifetime Cancer Risk	
		Child	Adult			Child	Adult
<b>PCBS Area</b>							
<b>Organics</b>							
Benzo(a)anthracene	10 *	1.21E-05	2.05E-05	7.3E-01	B2	9E-06	2E-05
Benzo(a)pyrene	8 *	9.64E-06	1.64E-05	7.3E+00	B2	7E-05	1E-04
Benzo(b)fluoranthene	8.4	1.01E-05	1.73E-05	7.3E-01	B2	7E-06	1E-05
Dibenz(a,h)anthracene	0.74 *	8.92E-07	1.52E-06	7.3E+00	B2	7E-06	1E-05
Indeno(1,2,3-c,d)pyrene	0.769	9.27E-07	1.58E-06	7.3E-01	B2	7E-07	1E-06
PCB-1260	0.702 *	5.08E-07	8.65E-07	2.2E+00	B2	1E-06	2E-06
<b>Total:</b>						9E-05	2E-04

\* Maximum detected value.

**TABLE 3-54**  
**EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SURFACE SOIL**  
**BY HYPOTHETICAL FUTURE WORKERS AT OU3**

**FUTURE LAND-USE CONDITIONS**

Carcinogenic Chemical	RME Exposure Point Concentration (mg/kg)	Lifetime Average Daily Dose (mg/kg-day)	Slope Factor (mg/kg-day) <sup>-1</sup>	Weight-of-Evidence Classification	RME Excess Lifetime Cancer Risk Child
<b>PCBS Area</b>					
<b>Organics</b>					
Benzo(a)anthracene	10 *	1.75E-06	7.3E-01	B2	1E-06
Benzo(a)pyrene	8 *	1.40E-06	7.3E+00	B2	1E-05
Benzo(b)fluoranthene	8.4	1.47E-06	7.3E-01	B2	1E-06
Dibenz(a,h)anthracene	0.74 *	1.29E-07	7.3E+00	B2	9E-07
Indeno(1,2,3-c,d)pyrene	0.769	1.34E-07	7.3E-01	B2	1E-07
PCB-1260	0.702 *	1.23E-07	2.0E+00	B2	2E-07
<b>Total:</b>					1E-05

\* Maximum detected concentration.

**TABLE 3-55**  
**EXPOSURES AND RISKS ASSOCIATED WITH DERMAL ABSORPTION OF CHEMICALS IN SURFACE SOIL**  
**BY HYPOTHETICAL FUTURE WORKERS AT OU3**

**FUTURE LAND-USE CONDITIONS**

Carcinogenic Chemical	RME Exposure Point Concentration (mg/kg)	Lifetime Average Daily Dose (mg/kg-day)	Adjusted Slope Factor (mg/kg-day) <sup>-1</sup>	Weight-of-Evidence Classification	RME Excess Lifetime Cancer Risk Child
<b>PCBS Area</b>					
<b>Organics</b>					
Benzo(a)anthracene	10 *	1.22E-05	7.3E-01	B2	9E-06
Benzo(a)pyrene	8 *	9.78E-06	7.3E+00	B2	7E-05
Benzo(b)fluoranthene	8.4	1.03E-05	7.3E-01	B2	8E-06
Dibenz(a,h)anthracene	0.74 *	9.05E-07	7.3E+00	B2	7E-06
Indeno(1,2,3-c,d)pyrene	0.769	9.41E-07	7.3E-01	B2	7E-07
PCB-1260	0.702 *	5.15E-07	2.2E+00	B2	1E-06
Total:					1E-04

\* Maximum detected concentration.



**TABLE 3-56**  
**EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SURFACE SOIL**  
**BY HYPOTHETICAL FUTURE ENVIRONMENTAL EDUCATORS AT OU3**

**FUTURE LAND-USE CONDITIONS**

Carcinogenic Chemical	RME Exposure Point Concentration (mg/kg)	Lifetime Average Daily Dose (mg/kg-day)	Slope Factor (mg/kg-day) <sup>-1</sup>	Weight-of-Evidence Classification	RME Excess Lifetime Cancer Risk Child
<b>PCBS Area</b>					
<b>Organics</b>					
Benzo(a)anthracene	10 *	3.49E-06	7.3E-01	B2	3E-06
Benzo(a)pyrene	8 *	2.80E-06	7.3E+00	B2	2E-05
Benzo(b)fluoranthene	8.4	2.94E-06	7.3E-01	B2	2E-06
Dibenz(a,h)anthracene	0.74 *	2.59E-07	7.3E+00	B2	2E-06
Indeno(1,2,3-c,d)pyrene	0.769	2.69E-07	7.3E-01	B2	2E-07
PCB-1260	0.702 *	2.45E-07	2.0E+00	B2	5E-07
<b>Total:</b>					3E-05

\* Maximum detected concentration.

**TABLE 3-57**  
**EXPOSURES AND RISKS ASSOCIATED WITH DERMAL ABSORPTION OF CHEMICALS IN SURFACE SOIL**  
**BY HYPOTHETICAL FUTURE ENVIRONMENTAL EDUCATORS AT OU3**

**FUTURE LAND-USE CONDITIONS**

Carcinogenic Chemical	RME Exposure Point Concentration (mg/kg)	Lifetime Average Daily Dose (mg/kg-day)	Adjusted Slope Factor (mg/kg-day) <sup>-1</sup>	Weight-of-Evidence Classification	RME Excess Lifetime Cancer Risk Child
PCBS Area					
Organics					
Benzo(a)anthracene	10 *	1.22E-05	7.3E-01	B2	9E-06
Benzo(a)pyrene	8 *	9.78E-06	7.3E+00	B2	7E-05
Benzo(b)fluoranthene	8.4	1.03E-05	7.3E-01	B2	8E-06
Dibenz(a,h)anthracene	0.74 *	9.05E-07	7.3E+00	B2	7E-06
Indeno(1,2,3-c,d)pyrene	0.769	9.41E-07	7.3E-01	B2	7E-07
PCB-1260	0.702 *	5.15E-07	2.2E+00	B2	1E-06
Total:					1E-04

\* Maximum detected value.

TABLE 3-58

## CUMULATIVE RISKS ASSOCIATED WITH EXPOSURES AT OU3

Receptor/Pathway	Cancer Risk	Non-cancer Hazard Index
<b>CURRENT LAND-USE CONDITIONS</b>		
<b>Trespasser/Recreational User:</b>		
<u>PCBs Area</u>		
Ingestion of sediment	$7 \times 10^{-7}$	NE
Dermal absorption of sediment	$2 \times 10^{-6}$	NE
Dermal absorption of surface water	NE	$<1 (1 \times 10^{-3})$
Ingestion of soil	$3 \times 10^{-6}$	NE
Dermal absorption of soil	$2 \times 10^{-5}$	NE
<b>Cumulative Risk</b>	$3 \times 10^{-5}$	$<1 (1 \times 10^{-3})$
<u>Pesticides Area</u>		
Ingestion of sediment	$3 \times 10^{-8}$	NE
Dermal absorption of sediment	$2 \times 10^{-7}$	NE
Dermal absorption of surface water	NE	$<1 (2 \times 10^{-2})$
<b>Cumulative Risk</b>	$2 \times 10^{-7}$	$<1 (2 \times 10^{-2})$
<b>FUTURE LAND-USE CONDITIONS</b>		
<b>Worker:</b>		
<u>PCBs Area</u>		
Ingestion of sediment	$2 \times 10^{-7}$	NE
Dermal absorption of sediment	$1 \times 10^{-7}$	NE
Ingestion of groundwater	$2 \times 10^{-7}$	$<1 (8 \times 10^{-1})$
Ingestion of soil	$1 \times 10^{-5}$	NE
Dermal absorption of soil	$1 \times 10^{-4}$	NE
<b>Cumulative Risk</b>	$1 \times 10^{-4}$	$<1 (8 \times 10^{-1})$
<u>Pesticides Area</u>		
Ingestion of sediment	$1 \times 10^{-8}$	NE
Dermal absorption of sediment	$8 \times 10^{-9}$	NE
<b>Cumulative Risk</b>	$2 \times 10^{-8}$	NE
<b>Environmental Educator:</b>		
<u>PCBs Area</u>		
Ingestion of sediment	$6 \times 10^{-6}$	NE
Dermal absorption of sediment	$1 \times 10^{-5}$	NE
Dermal absorption of surface water	NE	$<1 (3 \times 10^{-3})$
Ingestion of soil	$3 \times 10^{-5}$	NE
Dermal absorption of soil	$1 \times 10^{-4}$	NE
<b>Cumulative Risk</b>	$1 \times 10^{-4}$	$<1 (3 \times 10^{-3})$
<u>Pesticides Area</u>		
Ingestion of sediment	$3 \times 10^{-7}$	NE
Dermal absorption of sediment	$1 \times 10^{-6}$	NE
Dermal absorption of surface water	NE	$<1 (4 \times 10^{-2})$
<b>Cumulative Risk</b>	$1 \times 10^{-6}$	$<1 (4 \times 10^{-2})$

TABLE 3-58

## CUMULATIVE RISKS ASSOCIATED WITH EXPOSURES AT OU3

Receptor/Pathway	Cancer Risk	Non-cancer Hazard Index
<b>FUTURE LAND-USE CONDITIONS (continued)</b>		
<b>Child Resident:</b>		
<u>PCBs Area</u>		
Ingestion of sediment	$5 \times 10^{-6}$	NE
Dermal absorption of sediment	$4 \times 10^{-6}$	NE
Dermal absorption of surface water	NE	<1 ( $4 \times 10^{-3}$ )
Ingestion of groundwater	$3 \times 10^{-7}$	>1 (5)
Dermal absorption of groundwater	$2 \times 10^{-7}$	<1 ( $6 \times 10^{-2}$ )
Ingestion of surface soil	$9 \times 10^{-5}$	NE
Dermal absorption of surface soil	$9 \times 10^{-5}$	NE
<b>Cumulative Risk</b>	$2 \times 10^{-4}$	>1 (5)
<u>Pesticides Area</u>		
Ingestion of sediment	$2 \times 10^{-7}$	NE
Dermal absorption of sediment	$3 \times 10^{-7}$	NE
Dermal absorption of surface water	NE	<1 ( $5 \times 10^{-2}$ )
<b>Cumulative Risk</b>	$5 \times 10^{-7}$	<1 ( $5 \times 10^{-2}$ )
<b>Adult Resident:</b>		
<u>PCBs Area</u>		
Ingestion of fish (a)	$5 \times 10^{-3}$	<1 ( $4 \times 10^{-1}$ )
Ingestion of groundwater	$6 \times 10^{-7}$	>1 (2)
Dermal absorption of groundwater	$6 \times 10^{-7}$	<1 ( $4 \times 10^{-2}$ )
Ingestion of surface soil	$5 \times 10^{-5}$	NE
Dermal absorption of surface soil	$2 \times 10^{-4}$	NE
<b>Cumulative Risk</b>	$5 \times 10^{-3}$	>1 (2)

(a) The most conservative value for eel was used.

NE = Not Evaluated, since no chemicals in this grouping (i.e., carcinogenic/noncarcinogenic) were evaluated.

**Appendix B**  
**Ecological Risk Assessment for Operable Unit Three**

## **4.0 ECOLOGICAL RISK ASSESSMENT**

The purpose of the ERA is to assess the potential for adverse effects to non-human receptors resulting from exposure to chemicals at WRF. The ERA was conducted in accordance with national and regional USEPA guidance for evaluating ecological risks at hazardous waste sites (USEPA, 1989a,b, 1992a, and 1994a) and in accordance with relevant Army guidance (Wentzel et al. 1994). Consistent with this guidance, the approaches used in the ERA are similar to those used in the HHRA. The physical features of the site are first described and individual organisms, populations, or communities likely to occur at WRF are identified. The COPC are then identified along with the pathways by which ecological receptors could be exposed to chemicals. The potential toxicity of the COPC to ecological receptors selected for evaluation is then characterized. Finally, information on exposure and toxicity are combined to derive qualitative or quantitative estimates of the potential for adverse effects to ecological resources at WRF.

### **4.1 PROBLEM FORMULATION**

The problem formulation section of the ERA evaluates available information about the site history and past land use activities, the ecological resources and COPC associated with the site, and the pathways by which ecological receptors could be exposed to these chemicals. The section concludes with the identification of the ecological resources and the endpoints selected for evaluation in the ERA.

The problem formulation section is broken down into the following sub-sections. Section 4.1.1 provides a general overview of WRF and includes a description of the topography, past and present land use patterns, contaminants known to be associated with on-site activities, and the habitats/ecological resources known or likely to occur on-site. Section 4.1.2 identifies the COPC selected for evaluation and the data groupings selected for each media. Section 4.1.3 identifies the ecological receptor species and potential exposure pathways selected for evaluation. Finally, Section 4.1.4 discusses the assessment endpoints identified for evaluation in the ERA, and the methods and/or data used for this evaluation.

#### **4.1.1 Site Description**

##### **4.1.1.1 General Site Description and Discussion of Past On-site Activities**

WRF is approximately 580 acres in size and is located in Prince William County, Virginia (Figure 2-1). It is bounded by Marumsco Creek (part of Marumsco National Wildlife Refuge) to the west and by Occoquan and Belmont bays to the south and east, respectively. Although the majority of WRF is undeveloped, residential, commercial, and industrial areas are located directly north of the installation boundary. A residential community and golf course are presently under construction (beginning in summer 1995) along the northern installation boundary.

The topography of WRF is generally flat, with a gentle slope to the south and east. The topographic high, 30 feet, occurs at the western installation boundary and Marumsco Creek shoreline. WRF lies within the western portion of the Coastal Plain Physiographic Province, approximately eight miles east of the Fall Line.

The OU3 portion of WRF (refer to Figure 2-20) consists of the Main Ditch that runs from the northern property boundary to the point where it discharges into the Occoquan and Belmont bays and the area that is located between the Main Ditch and the northern boundary of the Main Compound (portions of AREEs 11 and 17). The upper section of OU3 is comprised of two branches. The northern branch receives discharge from an area north of the facility boundary as well as runoff from on-site areas. At the time of the RI, the area to the north of WRF was being cleared of trees for the development of a golf course and private residences. The northwestern branch originates close to main entrance of the facility and receives runoff predominantly from on-site locations. The two branches converge approximately 1,000 feet to the east of the western facility boundary. Following the convergence of the north and northwestern branches, the Main Ditch travels approximately 1,500 feet to a location adjacent to the Main Compound, where it receives discharge from a ditch which drains the Main Compound area. The Main Ditch travels roughly 1,000 feet further to the east and turns abruptly to the south, where it crosses Charlie Road and ultimately discharges to the Occoquan and Belmont bays.

WRF was acquired by the US Army in 1952, prior to this the site was used primarily for agricultural purposes. WRF was used as an electronics testing facility with activities ranging from receiving and transmitting radio signals to testing the effects of electromagnetic pulses on electronic equipment. These activities required the construction and use of large antenna arrays at locations throughout the facility. Disposal of equipment and material also occurred at WRF. Section 2.2 of the FFS should be referred to for a detailed description of past on-site activities at WRF.

#### 4.1.1.2 Description of Habitats and Wildlife at the Woodbridge Research Facility

Only approximately 24 of the 580 acres on WRF support improvements such as buildings, roads, and parking areas. The remaining 556 acres consist of undeveloped land, much of which was used during testing. The habitat surrounding OU3 consists primarily of open fields and palustrine wetlands. Woodland areas (excluding those considered wetlands) occur primarily along the western installation boundary outside of the drainage basin for the Main Ditch. A brief description of these habitats is given below, for a more detailed description please refer to the Environmental Impact Statement (EIS) (USACE, 1994).

Open Field Habitats. Open field habitats surround most of OU3 upstream of the discharge from the Main Compound area. Open field habitats consist of large areas that were kept mowed during the active life of the facility. The frequency of mowing has decreased since the facility is no longer active. Much of the open areas surrounding the drainage ditches is considered wetlands. The vegetative community of the open field areas is dominated by jointgrass (*Manisuris cylindrica*), dropseed grass (*Muhlenbergia expansa*), bush clover (*Lespedeza capitata*), white-top sedge (*Dichromena clorata*), broomsedge (*Andropogon virginicus*), and yellow foxtail (*Setaria glauca*) among others. In many of the open fields sweetgum (*Liquidambar styraciflua*) saplings occur in abundance. Several bird species are expected to use the open field habitat for feeding, nesting, or roosting. Examples of the bird species expected to occur include bobwhite quail (*Colinus virginianus*), mourning dove (*Zenaida macroura*), eastern bluebird (*Sialia sialis*), red-tailed hawk (*Buteo jamaicensis*), and a variety of finches and sparrows. Bald eagles (*Haliaeetus leucocephalus*) have been observed roosting and flying over WRF. Mammals expected to occur include groundhog (*Marmota monax*), whitetail deer (*Odocoileus virginianus*), and red fox (*Vulpes vulpes*). Other animals observed or expected to utilize the open field habitats of WRF include, snakes, turtles, and mice.

Palustrine Wetlands. Wetlands follow the Main Ditch as it flows toward the southern boundary of OU3. The wetlands consist predominantly of open wetlands, becoming increasingly forested downstream from the swale which drains the Main Compound area. The most common tree species occurring in the wetland areas are black gum (*Nyssa sylvatica*), sweet gum, red maple (*acer rubrum*), and persimmon (*Diospyros virginiana*). Understory species are dominated by northern arrowwood (*Viburnum recognitum*) and silky dogwood (*Cornus amomum*). The more open wetlands are dominated by cattail species (*Typha* spp.), marsh mallow (*Hibiscus moscheutos*), swamp rose (*Rosa palustris*), buttonbush (*Cephalanthus occidentalis*), spatterdock (*Nuphar luteum*), soft rush (*Juncus effusus*), pickerel weed (*Pontederia cordata*), and pond lily (*Nuphar variegatum*). A variety of terrestrial animal species are expected to utilize the wetland habitats including, spotted salamander (*Ambystoma maculatum*), green frog (*Rana clamitans melanota*), pickerel frog (*Rana palustris*), eastern box turtle (*Terrapene carolina*), eastern painted turtle (*Chrysemys picta*), northern water snake (*Nerodia sipedon*), belted kingfisher (*Ceryle alcyon*), wood duck (*Aix sponsa*), mallard duck (*Anas platyrhynchos*), American black duck (*Anas rubripes*), Canada goose (*Branta canadensis*), great blue heron (*Ardea herodias*), great egret (*Casmerodius albus*), little blue heron (*Egretta caerulea*), black-crowned night-heron (*Nycticorax nycticorax*), green heron (*Butorides striatus*), raccoon (*Procyon lotor*), whitetail deer, and beaver (*Castor canadensis*). A heron rookery exists on Mason Neck Wildlife Refuge which is across Belmont Bay from WRF. Herons from the rookery are likely to utilize WRF aquatic habitats.

The upper portion of the Main Ditch is nontidal because of the presence of the beaver dam that is located approximately 1200 feet south of Charlie Road (refer to Figure 2-22). The upper reaches of the Main Ditch, above the discharge to the Main Ditch (which includes the northern

and northwestern branches), is less than two feet wide at most locations. Below the drainage swale from the Main Compound, the ditch widens into the wetland area described above. This area supports a variety of different fish and amphibian species, in addition to the a number of different aquatic invertebrates. The fish species known to occur in these waters include bluegill (*Lepomis macrochirus*), channel catfish (*Ictalurus punctatus*), carp (*Cyprinus carpio*), American eel (*Anguilla rostrata*), and black crappie (*Pomoxis nigromaculatus*). Largemouth bass (*Micropterus salmoides*) and several species of minnows are also likely to occur in the Main Ditch.

Woodlands. As discussed above, woodland areas of WRF (excluding those considered wetlands) are located primarily along the western installation boundary along Marumsco Creek National Wildlife Refuge. The woodlands are dominated by northern red oak (*Quercus rubra*), white oak (*Quercus alba*), chestnut oak (*Quercus prinus*), Virginia pine (*Pinus virginiana*), and American Beech (*Fagus grandifolia*). Animal species expected to occur in the woodland areas include a variety of birds such as American robin (*Turdus migratorius*), hairy woodpecker (*Picoides villosus*), downy woodpecker (*Picoides pubescens*), redtail hawk, and mammals such as whitetail deer, and gray squirrel (*Sciurus carolinensis*). Because of the proximity of the woodland habitats to the Main Ditch area of OU3 and the mobility of these species, it is possible these terrestrial wildlife species also occur infrequently in the area around OU3.

Threatened and Endangered Species. A threatened and endangered species search for the WRF was requested through both the State of Virginia Department of Conservation and Recreation and the U.S. Fish and Wildlife Service Chesapeake Bay Field Office. Results of both searches indicate the presence of bald eagle (*Haliaeetus leucocephalus*) on WRF (VDCR, 1995; USFWS, 1995). Bald eagle are currently listed as federally threatened. No known bald eagle nests occur directly on WRF though a communal bald eagle roost is present on Mason Neck, located to the east of the facility. Eagles are known to frequently travel between Mason Neck and the WRF. No other species of special concern were identified in either of the searches.

#### 4.1.2 Identification of Chemicals of Potential Concern

This section of the ERA identifies COPC for detailed evaluation in the ERA. In this section, the methodology used to select the COPC is described and the COPC are identified. Chemicals are selected for evaluation in the ERA if they (1) are presumed to be present because of past activities at the site, and (2) pose potential risks to ecological species. Chemicals associated with sampling or laboratory artifacts, or chemicals at or below naturally occurring background levels (as indicated by the reference samples) were not selected as COPC.

The following steps, which are in accordance with USEPA (1989a) guidance, were first used to summarize the analytical data for this RA:

- The samples were divided into data groupings by environmental medium and exposure area (site). The creation of these data groupings allows for the characterization of environmental conditions relevant to exposure and helps to determine exposure concentrations for target populations. A grouping of background data is used to determine if chemicals detected at a site are present at naturally occurring levels. The sample data groupings used in the ERA, including background data groupings, are described by environmental medium in the sections below.
- Sample data were compared to blank (laboratory, field, and trip) concentration data. If the chemical concentration detected in a site-related sample was less than 10 times (for common laboratory chemicals) or five times (for all other compounds) the concentration in the corresponding blank sample, the sample was considered a non-detect in accordance with USEPA (1994a) Region III guidance. The identification and validation of sampling or laboratory artifacts were performed prior to data summarization.
- As requested by USEPA (1994a) Region III guidance, the maximum concentration of a pair of duplicate or split samples (taken from the same location on the same date) was used to represent the concentration for that location. This differs from the human health RA where



the average of a pair of duplicate or split samples is used to represent the concentration at a location.

- The mean concentration of a chemical within a given medium and sample data grouping was calculated by averaging the detected concentration(s) with one-half the quantitation limit of the nondetect(s). It should be noted that when one-half the quantitation limit exceeds the maximum detected concentration in a sample grouping, the arithmetic mean could exceed the maximum detected concentration.

Following USEPA (1994a) Region III guidance, when one-half the sample quantitation limit of a nondetect was less than the ecological criterion<sup>1</sup> for a chemical in a given environmental medium and the sample quantitation limit is greater than the ecological criterion, then the criterion was used as a proxy concentration for the nondetect rather than one-half the quantitation limit. If, however, the sample quantitation limit is less than the ecological criterion then one-half the sample quantitation limit was used. As a result of this procedure, a few sample quantitation limits for nondetects were replaced by the appropriate ecological criterion before calculating the mean.

- Data that were rejected by the laboratory (R qualified) were not used in the ERA.
- Frequency of detection was calculated as the number of samples in which the chemical was detected over the total number of samples collected.

Once the sampling data were grouped and summarized, chemicals were selected for further evaluation. All organic chemicals detected within a data grouping were initially identified for evaluation in the ERA. Inorganic chemicals were identified for evaluation if they were detected at concentrations greater than those representing naturally occurring background levels using the following methodology:

- To determine if detected levels of inorganic chemicals present at the site are representative of naturally occurring background levels, on-site data for each sample data grouping were statistically compared to the reference data grouping for the particular medium, where a minimum of three on-site and reference samples was available.

When at least three samples were available for both the on-site and reference sample data sets, a two-tailed variance ratio test was first performed to determine if the variances of the on-site and reference data were similar. If the variances for a given chemical in a given medium were found to be similar, then the one-tailed pooled variance t-test was used to test for differences between on-site and reference means. If on-site and reference variances were found to differ significantly, a nonparametric test (the one-tailed Mann-Whitney test) was used to test for similarity between on-site and reference means. Inorganics that were within background levels based on these statistical tests were eliminated from further evaluation in the ERA. A detailed description of the statistical tests is presented in Zar (1984). Chemicals eliminated based on comparison to background concentrations were compared to available toxicity values in Appendix A.1.

When less than three samples were available for both the on-site and reference sample data sets, the maximum concentration of each inorganic detected at the on-site location was compared to the maximum concentration of that inorganic chemical detected in the reference data grouping. If the maximum concentration of the inorganic chemical detected at the on-site location exceeded the maximum background concentration of that inorganic chemical or if an inorganic chemical was not detected in relevant background data grouping, then that chemical was selected as a COPC and evaluated further in the ERA. Chemicals whose maximum concentrations were less than the background value were eliminated from

<sup>1</sup> Chronic Federal AWQC were used as ecological criterion for chemicals in surface water. Freshwater criteria were used for surface water samples taken from the Main Ditch. The lower of NOAA ER-L and USEPA draft sediment quality criteria were used as ecological criterion for chemicals in sediments. Because analogous criterion have not been developed for chemicals in soil, one-half the sample quantitation limit was used for chemical nondetects in surface soil.

further consideration in the ERA. Chemicals eliminated based on comparison to background concentrations were compared to available toxicity values in Appendix A.1.

- Some analytes collected during the sampling events were not presented or evaluated in the ERA, including TPH (for which no toxicity criteria are available) and some water/sediment parameters (e.g., sediment moisture). Section 2.0 of the FFS should be referred to for an identification of the samples in which these analytes were analyzed for, and for a summary of these data.

Additionally, essential nutrients (i.e., calcium, magnesium, potassium, sodium) were not selected for evaluation because they are unlikely to adversely affect ecological receptors at concentrations that could occur in the environment.

Exposure point concentrations were calculated for the maximum case concentration and, where appropriate for the receptor being evaluated, the average case concentration (see Section 4.2). A summary of the chemicals identified for further evaluation in the ERA, the data groupings, and the reference sample locations are presented for each medium in the discussion below.

Chemical analytical data from sediment (0-6 inches), surface water, and fish tissue samples collected from OU3 were evaluated in the focused ERA. The results of the chemical analyses for each of these media are summarized below.

#### **4.1.2.1 Sediment**

A total of 10 sediment samples, collected during the RI from an area between the origins of the OU3 drainage on-site and an area just south of Charlie Road, were evaluated in the ERA. All samples were grouped for analyses. Five discrete background sediment samples were collected from the Mason Neck Wildlife Refuge which has not been impacted by past activities at WRF. The locations of the on-site and upgradient samples are shown in Figures 2-4 and 2-5, respectively. All sediment samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PAHs, and PCTs, with the exception of RISD35, which was not analyzed for PCTs.

Chemicals detected in the sediment samples on OU3 are summarized in Table 4-1. A total of 21 organic chemicals were detected in these samples, consisting of 16 PAHs, 4 pesticides, and PCB-1260. Of the inorganic chemicals detected in sediment, only barium and lead were detected at concentrations above background and identified as COPC.

#### **4.1.2.2 Surface Water**

Surface water on-site and reference samples were collected during the RI from the same locations at which the sediment samples were collected. Accordingly, the same data groupings that were used for the sediment samples were also used for surface water for the evaluation of the data. All surface water samples were analyzed for TCL VOCs, TCL SVOCs, pesticides/PCBs, TAL metals, PAHs, and PCTs.

Chemicals detected in the surface water samples from OU3 are summarized in Table 4-2. The following inorganic chemicals were detected at concentrations above background and preliminarily identified as COPC: aluminum, barium, cadmium, chromium, copper, lead, thallium, vanadium, and zinc. Potassium was detected at concentrations above background but is an essential nutrient and unlikely to adversely affect potential ecological receptors at the detected concentrations, and therefore, not identified as a COPC.

#### **4.1.2.3 Fish Residue**

As part of the Woodbridge Site Investigation, Earth Tech was contracted by USAEC to conduct biota sampling for tissue residue analysis in late 1995. The biota sampling included fish sampling in the Main Ditch from an area immediately downstream from the location of the furthest downgradient sediment sample (see Figure 2-4).<sup>2</sup> Fish were collected using nets, seines, and electro-fishing gear. A

<sup>2</sup> Available information suggests fish were collected predominantly from a location upstream of the beaver dam on the Main Ditch, though it is possible that some fish were collected from below the dam.

detailed description of the fish sampling program along with an identification of each sample/test location is presented in Appendix B. All fish samples were analyzed for TCL pesticides, PCBs, PCTs, lead, and mercury.

The results of the whole body fish tissue residue analyses are summarized in Table 4-3 as both nonlipid-adjusted whole body tissue concentrations and lipid-adjusted concentrations.<sup>3</sup> Both whole body and fillet samples were collected from the Main Ditch; however, only the wholebody data was summarized in Table 4-3 because those results are the most applicable to the ERA. Furthermore, the nonlipid-adjusted concentrations were the focus of the present assessment because they were the most applicable to the exposure pathways evaluated and toxicity values used in the present assessment. Accordingly, only the nonlipid-adjusted concentrations were summarized in the text below and evaluated in the ERA.

As shown in Table 4-3, DDT metabolites were detected in all of the fish species collected from the Main Ditch. The highest concentrations of both DDD and DDE (325 µg/kg and 167 µg/kg wet weight, respectively) were detected in carp, while DDT metabolite concentrations were below 85 µg/kg in all other fish species. Chlordane (detected as alpha- and gamma-chlordane) was also detected in carp (concentrations up to 9.97 µg/kg and 5.85 µg/kg wet weight, respectively) and eel (concentrations up to 8.25 µg/kg and 2.31 µg/kg wet weight, respectively), but was not detected in either crappie or sunfish. PCB-1260 was detected in all of the fish and eels, with the highest concentration of 1,090 µg/kg (wet weight) PCB-1260 detected in eels. Mercury was detected in crappie, eel, and sunfish at concentrations of up to 0.207 µg/kg wet weight in crappie.

#### 4.1.3 Identification of Exposure Pathways and Receptors for Analysis

In this section of the ERA, the potential pathways by which ecological resources may be exposed to the COPC at WRF are discussed. Exposure pathways were identified based on the consideration of (1) the source/mechanism of chemical release; (2) the medium (or media) of chemical transport; (3) the point of potential contact by the receptor organism; and (4) the route of exposure at the contact point. Potentially complete exposure pathways and potential receptor groups were identified for evaluation in the ERA based on consideration of the available habitat, and the type, extent, magnitude, and location of potential chemical contamination.

As previously discussed (Section 4.1.1.2), a variety of different plant, wildlife species, and aquatic life are associated with OU3. Figure 4-1 provides a conceptual model of the primary on-site sources of contamination and the potential pathways by which ecological receptors could contact these sources. Table 4-4 provides a more detailed description of the potential exposure pathways by which potential ecological receptors could be exposed to COPC at OU3 and identifies, in general terms, the pathways selected for evaluation in the ERA. A brief rationale for the selection/exclusion of each potentially complete exposure pathway is also summarized in this table. The following sections provide a more detailed discussion and evaluation of the pathways by which potential receptors could be exposed to COPC in surface water and sediment and discusses the exposure pathways selected for evaluation.

##### 4.1.3.1 Aquatic and Terrestrial Plants

Aquatic and terrestrial plants are important components in any ecosystem because they provide food and cover for many wildlife species. WRF supports a variety of different plant species characteristic of both upland and wetland areas.

Aquatic and wetland plants may be exposed to chemicals in surface water or sediment. Terrestrial plants adjacent to the Main Ditch also may be exposed to chemicals in sediment and/or mobilized in surface water. However, very little information is available to evaluate exposures via foliar uptake or via contact with surface water or sediment. Accordingly, this potential exposure pathway was not evaluated in the ERA.

<sup>3</sup> Whole body fish tissue residue data (both whole body tissue concentrations and lipid-adjusted concentrations) is summarized in relation to body size in Appendix A.2.

#### 4.1.3.2 Terrestrial Wildlife

Terrestrial wildlife occurring at WRF may be exposed to COPC in the Main Ditch by several pathways, including (1) the ingestion of contaminated sediment or food while foraging or grooming; (2) the ingestion or dermal absorption of chemicals from surface water; and (3) the dermal absorption of chemicals from sediment.

Among these potential exposure pathways, the greatest potential for exposure to chemicals is likely to result from the ingestion of chemicals that have accumulated in the food. This conclusion is based on both the potential for some chemicals to accumulate to higher concentrations in food than in the abiotic media from which they originate and on the relatively high ingestion rate of food as compared to surface soil. Accordingly, the potential for the exposure of terrestrial wildlife to chemicals in food was considered for evaluation.

Both organic and inorganic chemicals detected in sediment and surface water were reviewed for their potential to accumulate in aquatic and/or terrestrial food webs.<sup>4</sup> Chemicals having a bioconcentration factor (BCF) of greater than 300 or, in the case of organics, a octanol/water partition coefficient (expressed as log Kow)<sup>5</sup>, of greater than three were initially considered for evaluation based on USEPA (1989a) guidance. Based on the results of this screen, chemicals identified as having the greatest potential to accumulate are summarized below.

Sediment: The organic chemicals chlordane, DDD, PAHs, and PCB-1260 were detected in OU3 and have the potential to accumulate in the aquatic food web based on the parameters outlined above. However, if PAH accumulation is occurring, it would be limited to aquatic invertebrates and plants as PAHs are metabolized by most higher level species. Furthermore, chlordane and DDD were detected at only two sample locations in locations sampled in OU3 and the potential for accumulation is, therefore, likely to be limited. However, because of chlordanes' and DDDs' potential to accumulate, these compounds were considered further in the ERA. No inorganic chemicals which have the potential to accumulate were detected in sediment.

Surface Water: No organic chemicals detected in surface water have the potential to accumulate in the aquatic environment. Cadmium and zinc, both of which have BCFs greater than 300 for some aquatic species, were also detected in surface water at concentrations above background. However, cadmium and zinc were detected at concentrations less than chronic federal AWQC, therefore, it is reasonable to conclude that these compounds would not accumulate in the aquatic environment at the detected concentrations. Accordingly, no inorganic chemicals in surface water are likely to accumulate in the aquatic environment.

After the chemicals that could accumulate in the terrestrial environment from sediment (PCB-1260, and to a lesser extent chlordane, DDD, and PAHs) were identified, the possible pathways by which receptor species could be exposed were evaluated. Emphasis was placed on higher trophic-level species because of the potential for bioaccumulation in the food web prior to the exposure of these receptors. To identify potentially impacted species, the feeding guilds of the mammals and birds known to occur at WRF were reviewed to identify the possible dietary routes by which mammals and birds could be exposed to bioaccumulative chemicals. A summary of the feeding guilds identified for avian species and mammals known to occur at WRF is presented in Tables 4-5 and 4-6, respectively, along with a list of representative species. The tables also summarize the exposure routes and species selected for evaluation in the OU3 ERA and provide a brief rationale for the selection/exclusion of each potentially complete exposure route. The following section provides a more detailed discussion of the information provided in these tables.

<sup>4</sup> Wildlife could be affected by the accumulation of chemicals from surface soil; however, only sediment and surface water samples were evaluated in the OU2 investigation and potential exposure pathway(s) originating from soil were not considered in the present assessment.

<sup>5</sup> The octanol/water partition coefficient of an organic chemical characterizes the propensity of a chemical to partition into the lipid fraction of an organism, and thus, the potential for a chemical to bioaccumulate in an organism.

**Exposure from Accumulation in the Aquatic Food Web.** Birds and small mammals could be exposed to chemicals at WRF via the ingestion of aquatic life that have accumulated chemicals and this exposure pathway is potentially complete because of the presence of bioaccumulative compounds in sediment. As previously discussed, none of these chemicals were detected in surface water, and this media does not represent a significant exposure pathway.

The predominant food sources for birds and small mammals from the water bodies on and around WRF are likely to consist of aquatic invertebrates and fish. With the exception of PAHs, fish are likely to have the greatest potential to accumulate chemicals from sediment into the aquatic food web and represent an important potential exposure pathway to higher level receptors for the following reasons. First, fish represents a high trophic-level species in the aquatic environment at WRF. Furthermore, fish are an important food source for a number of terrestrial predators and represent a viable exposure pathway. Finally, fish have the potential to accumulate all of the bioaccumulative COPC, with the exception of PAHs, which are typically metabolized by fish. Accordingly, fish were selected to evaluate the potential for chlordane, DDT<sub>r</sub>, and PCBs to accumulate from sediment to higher trophic level species.

Heron were selected as an avian receptor species for evaluating potential adverse effects to birds from the ingestion of fish. Heron were selected for evaluation because a large proportion of their diet is comprised of fish. Furthermore, a heron rookery is present on Mason Neck Wildlife Refuge located immediately across Belmont Bay and within approximately two miles of WRF, and heron have been observed regularly foraging in the water bodies on WRF. A number of small mammals (e.g., mink, raccoon, shrew) are also known to occur on WRF and were considered for evaluation in the ERA. Mink were selected for evaluation because they ingest fish and are known to be extremely sensitive to PCBs, and thus, represent a sensitive indicator of the potential for adverse effects to piscivorous small mammals.

In addition to the ingestion of chemicals from fish and aquatic invertebrates, heron and mink could be exposed to chemicals from the ingestion of sediment, surface soil, and surface water while foraging or grooming. Based on the foraging habits of these species, sediment ingestion is likely to be much greater than soil and this potential exposure pathway was also selected for evaluation. None of the potentially bioaccumulative chemicals discussed above were detected in surface water, and this medium does not represent a significant exposure pathway for these chemicals.

Aquatic invertebrates also have the potential to accumulate chlordane, DDD, and PCB-1260 from sediment (USEPA, 1980). Additionally, PAHs, which are metabolized in fish, readily accumulate in aquatic invertebrates. Further, aquatic invertebrates are likely to represent an important food source for a variety of terrestrial wildlife species (e.g., dabbling ducks, raccoons). Of the aquatic invertebrates occurring on WRF, freshwater clams, which were observed in the lower reaches of the Main Ditch, are likely to comprise some of the greatest biomass of the organisms in sediment and represent an important potential exposure pathway. Accordingly, the ingestion of aquatic invertebrates was selected as a potential exposure route for the evaluation of potential adverse effects to terrestrial species from the accumulation of the bioaccumulative COPC. However, the evaluation of the potential for adverse effects to terrestrial wildlife from the ingestion of aquatic invertebrates will be evaluated in the site wide ERA instead of the OU3 evaluation.

Aquatic plants, though potentially a route of exposure for herbivorous species (e.g., dabbling ducks), are unlikely to represent an important route of exposure to these species given the more limited potential of these chemicals to accumulate in plant material.

#### **4.1.3.3 Aquatic Life**

Aquatic life could potentially be exposed to chemicals in OU3 by direct contact with contaminated water and sediment, respiration of chemicals in water and sediment, and ingestion of contaminated sediments and food. Aquatic life also could be exposed to chemicals via the ingestion of chemicals that have accumulated in the food web. As discussed earlier, the potential for adverse effects to terrestrial life from the ingestion of chemicals in aquatic life was selected for evaluation in the ERA.

Potential risks to aquatic life were evaluated in the Risk Characterization section (Section 4.4) of the ERA by comparing concentrations of the COPC identified in surface water and sediment to applicable toxicity values derived in the Ecological Effects Assessment section (Section 4.3) of the ERA. Because the toxicity data being used in the ERA were designed to evaluate the potential for adverse effects to aquatic communities, no specific aquatic species were selected for evaluation and the assessment evaluated the potential for adverse effects to the overall aquatic community.

#### 4.1.4 Identification of Assessment and Measurement Endpoints

As discussed earlier, the potential for adverse effects to ecological resources is dependent on the ecological receptor species and chemicals present on the site, and the pathways by which the ecological resources could be exposed to the COPC. Section 4.1.1 preliminarily identified ecological resources occurring on the site that could be adversely affected by the presence of chemicals. Section 4.1.2 preliminarily identified the COPC present in each of the on-site media. Finally, Section 4.1.3 preliminarily identified the potential exposure pathways by which ecological receptors could be exposed to COPC, based on information about the presence of ecological resources on site and on information about the presence of COPC in each sampled environmental media. This section of the report summarizes the specific ecological parameters for each of the evaluated receptors by identifying the assessment endpoint, the hypothesis being tested in the investigation, and measurement endpoints selected for the evaluation of the assessment endpoints.

Assessment endpoints are defined as the ecological effects in the receptor species selected for evaluation. The evaluation of the potential for ecological effects to occur is one factor in the decision making process regarding the need for further investigation and/or remediation (Suter, 1993). For example, the reproductive capability of the receptor species and/or population may be an assessment endpoint selected for evaluation. Measurement endpoints are the outcomes of the methods or means by which the assessment endpoints are approximated or represented (Suter, 1993). Measurement endpoints are generally surrogates for assessment endpoints and are necessary because, in most cases, assessment endpoints cannot be directly measured or observed. Typically, the measurement endpoints are the result of or outcome of the field and/or laboratory methods used to evaluate the assessment endpoints. For example, the measurement endpoint for the evaluation of the potential for adverse effects to receptor organisms, populations, and/or communities may be the concentration of a chemical measured in an abiotic media to which the receptor species could be exposed compared to an applicable toxicity value and/or may be the results of a fish population survey from the area of concern.

The assessment and measurement endpoints selected for evaluation in the OU3 ERA are summarized in Table 4-7. In addition, Table 4-7 states formal testable hypotheses for each of the assessment endpoints selected for evaluation.

## 4.2 EXPOSURE ASSESSMENT

The purpose of the exposure assessment is to identify the concentration and/or dose of the COPC to which ecological resources selected for evaluation in the ERA could be exposed. The following sections discuss the evaluation of exposure and identify the exposure concentrations selected for the evaluation of potential adverse effects to each of the ecological receptor groups/organisms selected for evaluation.

### 4.2.1 Terrestrial Wildlife

The following discussion presents the methods used to calculate the potential ingestion of chemicals by heron and mink via the ingestion of fish and sediment. The equations presented below were derived based on equations presented in USEPA (1989a).

The following equation was used to calculate the dose of chemicals that a heron or mink would be expected to obtain from the ingestion of fish:

$$\text{Dose}_{\text{fish}} = \text{FI} * C_{\text{diet}}$$

where:

$Dose_{fish}$  = amount of chemical ingested per day via the ingestion of fish (mg/kg bw-d);

FI = food ingestion rate (kg/kg bw-d);

$C_{diet}$  = estimated COPC concentration in diet (mg/kg).

A food ingestion rate (FI) of 0.18 kg/kg bw-d reported by Kushlan (1978) for great blue heron was used in the ERA. A FI of 0.22 kg/kg bw-d estimated in USEPA (1993) using an equation by Nagy (1978) and body weight reported by Mitchell (1961) for mink was used in the ERA.

The estimated dietary concentration ( $C_{Diet}$ ) was calculated using the following equation:

$$C_{diet} = P_f * C_f$$

where:

$P_f$  = proportion of diet consisting of fish (unitless)

$C_f$  = estimated concentration of COPC in fish (mg/kg).

The proportion of the diet ( $P_f$ ) consisting of fish was based on information obtained from the scientific literature. Alexander (1977) reported a year-round  $P_f$  of 98% for heron living near a river and 61% for mink living near a stream. For both heron and mink it was assumed that 100% of the fish ingested are from the sampled area of the Main Ditch. This assumption is conservative and may lead to an overestimate of potential risks because both species are likely to obtain some food from areas outside of OU3, and in the case of heron, outside the bounds of WRF.

Chemical concentrations measured in whole body fish tissue were used to estimate  $C_f$ .

The average concentration of each chemical detected in all sampled fish (see Table 4-3) was used in the model because it was determined to most accurately estimate the exposure of these predators foraging in the environment.

In addition to the ingestion of chemicals accumulated in fish, heron and mink also may be exposed to chemicals through the inadvertent ingestion of sediment while foraging or grooming. The following equation was used to calculate the dose of chemical these species would be expected to obtain from the ingestion of sediment:

$$Dose_{sediment} = SI * C_{sediment}$$

where:

$Dose_{sediment}$  = amount of chemical ingested per day from sediment (mg/kg bw-d);

SI = sediment ingestion rate (kg/kg bw-d);

$C_{sediment}$  = average COPC concentration in sediment (mg/kg).

Based on percent dietary soil/sediment ingestion presented by Beyer et al. (1994), it was assumed that 8.2% of the total mass of a heron's diet and 9.4% of the total mass of a mink's diet is sediment. The percent sediment ingestion was multiplied by the food ingestion rates (FI) presented earlier for these species to estimate sediment ingestion rates (0.015 kg/kg bw-d for heron and 0.02 kg/kg bw-d for mink). As for the estimation of exposure to chemicals in fish tissue, the average chemical concentration was used for  $C_{sediment}$ .

The total dietary exposure levels for mink and heron to DDT<sub>r</sub> was determined using the following equation:

$$\text{Dose}_{\text{total}} = \text{Dose}_{\text{fish}} + \text{Dose}_{\text{sediment}}$$

Using the above equation, the estimated total dose of chemicals from the ingestion of fish tissue and sediment was determined. The estimated total dose is presented in Section 4.4.1 where it is compared to toxicity values derived in Section 4.3.1 for mink and heron.

## 4.2.2 Aquatic life

### 4.2.2.1 Sediment

Chemical concentrations measured in sediment from locations towards the upper portions of the Main Ditch were used to evaluate the potential for adverse effects to benthic organisms. Maximum chemical concentrations measured in sediment samples are given in Table 4-1 for OU3. The maximum concentration was used for the initial evaluation because, based on the relative immobility of most aquatic invertebrates, exceedence of a toxicity value at a sample location indicates the potential for adverse effects at that location. The potential for adverse effects at the community level can then be evaluated by identifying the overall proportion of sample locations where the toxicity value is exceeded.

### 4.2.2.2 Surface Water

Chemical concentrations measured in surface water from OU3 were used to evaluate the potential for adverse effects to aquatic life. Average concentrations measured in surface water samples are given in Table 4-2. Based on the mobility of most aquatic species and the transient nature of surface water, particularly flowing water, the average chemical concentrations measured in the surface water samples best represent the exposure concentrations to which the aquatic life in a water body could be exposed and were selected for evaluation.

## 4.3 ECOLOGICAL EFFECTS ASSESSMENT

### 4.3.1 Terrestrial Life

Toxicity criteria have not been developed by USEPA for terrestrial species. Consequently, toxicity data in the scientific literature were reviewed to characterize the toxicity of the COPC selected for evaluation. Toxicity values selected for the evaluation of the potential for adverse effects are referred to as toxicity reference values (TRVs) and represent concentrations of the COPC that are protective of the ecological receptors being evaluated.

As previously discussed, risks to heron and mink from the ingestion of fish and sediment were selected for evaluation. Toxicological benchmarks derived by Opresko et al. (1994) were used to evaluate the potential for adverse effects to the receptors of concern.

### 4.3.2 Aquatic Life

#### 4.3.2.1 Surface Water

Federal AWQC were developed by USEPA for the protection of aquatic life and were used to assess potential impacts to aquatic species. Both chronic and acute freshwater AWQC were used to evaluate the potential for adverse effects to aquatic life. Acute AWQC were used in the comparison because a storm event was occurring at the time of sampling and there is the potential for a "pulse" of chemicals to have been released in surface water as a result of increased surficial runoff. Chronic freshwater AWQC also were used to evaluate the potential for adverse effects to aquatic life in case the detected concentrations are indicative of longer-term exposure. For hardness-dependent criteria, the average hardness value measured in the ditches during the RI was 31.2 mg/l as CaCO<sub>3</sub> and was adjusted upward to 50 mg/l as CaCO<sub>3</sub> to be consistent with the minimum hardness value for which AWQC could be derived. In the absence of AWQCs, proposed criteria and toxicity data from the literature were used.



#### 4.3.2.2 Sediment

Two sources of toxicity data were used to identify the potential for chemicals in sediment to cause adverse effects to benthic communities. The USEPA Office of Water has developed draft sediment quality criteria (SQC) that represent the Agency's best recommendation of the concentrations of a substance in sediment that will not unacceptably affect benthic organisms (USEPA 1993). The methodology used to generate the proposed criteria is called the equilibrium partitioning (EqP) approach and applies only to non-ionic organic chemicals. Draft freshwater sediment criteria have recently been developed for three PAHs (fluoranthene, phenanthrene, and acenaphthene) and two pesticides (aldrin and dieldrin). In addition to the draft criteria, Effects Range-Low (ER-L) and Effects Range-Median (ER-M) values reported in Long and Morgan (1990) and subsequent updates in Long et al. (1995) were employed as TRVs to determine if chemicals in the sediments are likely to impact aquatic communities. Effects range values were derived from the compilation of the available sediment toxicity data for a chemical. The ER-L value is equivalent to the lower 10th percentile of the available toxicity data, which is estimated to be the approximate concentration at which effects are likely to occur in sensitive life stages and/or species. The ER-M value is equivalent to the median of the available toxicity data, which is estimated to be the approximate concentration at which effects are likely to occur in most species.

Available USEPA EqP draft criteria and ER-L/ER-M values were used to evaluate the potential for adverse effects to benthic communities. In the case where both USEPA EqP draft criteria and ER-L/ER-M values are available for a chemical, the lower of the two values was used to conservatively evaluate the potential for adverse effects to benthic communities. For these chemicals, freshwater EqP draft criteria were compared to the ER-L/ER-M values used to evaluate the potential for adverse effects to aquatic life in OU3. In the absence of the above guidelines, available toxicity values from the scientific literature were used as TRVs.

#### 4.4 RISK CHARACTERIZATION

In this section of the ERA, the potential exposure concentrations derived in Section 4.2 are compared with the TRVs derived in Section 4.3 to evaluate the potential for adverse effects to ecological resources from exposure to the COPC.

Estimated exposure concentrations for the COPC are compared to TRVs by creating a ratio of the estimated exposure concentration to the TRV. This ratio is termed the Environmental Effects Quotient (EEQ). If the EEQ is less than 1.0 (indicating the exposure concentration is less than the TRV) then adverse effects are considered unlikely. If the EEQ is equal to or greater than 1.0 (indicating the exposure concentration is greater than the TRV), there is a potential for adverse effects to occur. The confidence level of the conclusion increases as the magnitude of the ratio departs from 1.0. For example, there is greater confidence in a risk estimate where the EEQ is 0.1 or 10, than in a EEQ which is closer to 1.0. The uncertainties associated with the risk estimates are briefly discussed below and are discussed in greater detail in Section 4.5.

##### 4.4.1 Terrestrial Wildlife

Chemicals having the potential to bioaccumulate were detected in the sediment of OU3 and there is the potential for chemicals to accumulate in the aquatic environment. No chemicals having the potential to accumulate were detected in surface water, though it is expected that some fraction of the chemicals detected in sediment are partitioning to the water column, presumably at concentrations below the detection limits. The potential for terrestrial wildlife to be adversely affected by the ingestion of chemicals accumulated in the aquatic food web was evaluated in this section.

As discussed in Section 4.1.4, the potential for great blue heron and mink to be adversely affected from the ingestion of fish was selected for evaluation. The potential for adverse effects to terrestrial wildlife was evaluated on a chemical-by-chemical basis by:

- comparing chemical concentrations measured in fish tissue collected on-site and modeled ingestion estimates to literature-based toxicity values;

- comparing chemical concentrations detected in whole body fish samples tissue collected on site to chemical concentrations detected in whole body fish samples tissue collected from areas outside the influence of WRF;
- evaluating each chemical's occurrence in OU3 and in other on-site media; and, as needed,
- evaluating the life history characteristics of fish species in relation to the potential for chemical accumulation.

Table 4-8 compares the total dose of each chemical of potential bioaccumulative concern (calculated using the equations presented in Section 4.2.1) to the TRVs identified in Section 4.3.1. Figures 4-2 through 4-6 compare the concentrations of chemicals of bioaccumulative concern detected in whole body fish tissue collected from the Main Ditch to chemical concentrations detected in whole body fish tissue collected both locally and nationally. Fish were collected locally from Neabsco Creek, Farm Creek, Gunston Cove, Accotink Bay, and Pohick Bay as part of investigations designed to collect baseline data about the contaminant status of these areas (Block 1990, Pinkney et al. 1995). All of these water bodies are within highly urbanized watersheds. Catfish and largemouth bass were collected locally to represent both benthic-dwelling and predatory species from local water bodies because these species have some of the greatest potential to accumulate chemicals from the environment. Data from whole body fish tissue collected as part of the National Contaminant Biomonitoring Program (NCBP) and reported in Schmitt et al. (1990) were used for the comparison to national concentrations. The objective of the latter program was to identify chemical concentrations in a variety of different predatory and benthic-dwelling fish species collected nationally. The local and national accumulation data is intended to provide a frame of reference concerning the chemical concentration a terrestrial predator might be exposed to at on and off-site locations. It should be recognized, however, there are limitations associated with the use of the off-site data. For example, accumulation levels will vary dramatically with many factors including the species, size, and reproductive condition of the fish being sampled. As already stated above, bass and catfish have some of the greatest potential to accumulate chemicals from the environment and the accumulation potential of these species is likely to be greater than for the species collected in the Main Ditch at OU3. Accordingly, the accumulation data should not be used as a direct comparison for accumulation at on and off-site locations, but instead, should only be used to place the on-site data into a regional and national perspective.

The following sections use the above information to evaluate the potential for adverse effects to great blue heron and mink from each of the chemicals detected in whole body fish tissue samples.

**Chlordane.** As previously discussed, alpha- and gamma-chlordane were detected at two locations in sediment collected from the upper reaches of the OU3 drainage (RISD 27 and 28) and could be accumulating in fish tissue from on-site locations. The EEQ for both mink and great blue heron from the ingestion of chlordane in fish and sediment is less than one (see Table 4-8) and based on these results, it is reasonable to conclude that mink and great blue heron will not be adversely affected by the ingestion of chlordane in fish and sediment. Furthermore, chlordane was only detected in the area towards the upper reaches of OU3 and was not detected in sediment or surface water at locations where fish occur in OU3. Finally, the concentrations of alpha- and gamma-chlordane detected on-site were below those detected in either catfish or bass collected from local areas and below concentrations detected in fish species collected as part of the NCBP (see Figures 4-2 and 4-3) suggesting that potential predators could be exposed to chlordane at both off-site and on-site locations, and in some cases, to potentially higher concentrations at off-site locations.

**DDT/DDD/DDE.** DDD was detected at two locations in the sediment of OU3 (RISD 27 and 35) and could be accumulating in fish tissue from on-site locations. The EEQ for mink from the ingestion of DDT compounds in fish and sediment is less than one (see Table 4-8). Based on these results, it is reasonable to conclude that mink will not be adversely affected by the ingestion of DDT compounds in fish and sediment. The EEQ for great blue heron from the ingestion of DDT compounds in fish and sediment is 49.9. These results indicate the potential for adverse effects to great blue heron from the presence of DDT compounds in fish and sediment. However, the average concentrations of DDD detected in all fish species collected

from the Main Ditch were below those detected in either catfish or bass collected from local areas and below those detected in fish species collected as part of the NCBP (see Figure 4-4) suggesting that potential predators could be exposed to DDD at both off-site and on-site locations, and in some cases, to potentially higher concentrations at off-site locations.

**Heptachlor.** Heptachlor was not detected in surface water or sediment at any sample location in OU3, or in the surface soil of the drainage basin surrounding the Main Ditch. Further, the EEQ for mink from the ingestion of heptachlor in both fish and sediment is less than one (see Table 4-8). Based on these results, it is reasonable to conclude that mink will not be adversely affected by the ingestion of heptachlor in fish and sediment. Toxicity values could not be found in the scientific literature for great blue heron and the potential for heptachlor to adversely affect this species could not be evaluated. Heptachlor was not analyzed for in fish tissue samples collected as part of the regional sampling or the NCBP.

**PCB-1260.** As previously discussed, PCB-1260 was detected in sediment at all sample locations below the swale which discharges to OU3 from the former oil/water separator and former washrack (RISD 31 through 35) and could be accumulating in fish tissue from on-site locations. However, the EEQ for both mink and great blue heron from the ingestion of PCB-1260 in fish and sediment is less than one (see Table 4-8) and, based on these results, it is reasonable to conclude that mink and great blue heron will not be adversely affected by the ingestion of PCBs in fish and sediment. Because of its prevalence in sediment, the concentrations of PCB-1260 detected in the fish tissue are likely to be, at least in part, attributable to the PCB-1260 detected in samples collected from the upper reaches of the OU3 drainage. It should be noted, average PCB-1260 concentrations detected in catfish from the regional locations were less than those detected in benthic species collected from on-site locations (eel and carp) while the average PCB-1260 concentrations detected in all species at on-site locations were greater than the geometric mean concentrations detected in fish species collected as part of the NCBP (Schmitt et al. 1990) (see Figure 4-5).

**Mercury.** The EEQ for mink from the ingestion of mercury in fish and sediment is less than one (see Table 4-8). Based on these results, it is reasonable to conclude that mink will not be adversely affected by the ingestion of mercury in fish and sediment. The EEQ for great blue heron from the ingestion of mercury in fish and sediment is 5.8. These results indicate the potential for adverse effects to great blue heron from the presence of mercury in fish tissue. However, several factors must be considered when interpreting these results. First, mercury was not detected in the sediment and surface water in OU3. Further, the arithmetic mean mercury concentrations detected in all species collected from on-site locations remained below the average concentrations detected in fish sampled regionally (Block 1990, Pinkney et al. 1995) and below the geometric mean concentrations detected in fish sampled as part of the NCBP (Schmitt et al. 1990), respectively (see Figure 4-6). Although definitive statements cannot be made about mercury based on the number of on-site samples taken, these results suggest the mercury detected in fish tissue may not be originating from OU3. Furthermore, these data suggest potential predators could be exposed to elevated mercury concentrations at both off-site and on-site locations, and in some cases, to potentially higher concentrations at off-site locations.

**Summary and Discussion of Wildlife Results.** The results of the food web model indicate that mink are unlikely to be adversely affected by the ingestion of chlordane, heptachlor, or PCB-1260 in fish tissue while great blue heron are unlikely to be adversely affected by the ingestion of chlordane or PCB-1260 in fish tissue.<sup>6</sup> The results of the food web model also indicate mink are unlikely to be adversely affected by the ingestion of DDT compounds and mercury in fish tissue. The model does, however, suggest there is the potential for adverse effects to great blue heron from the ingestion of DDT compounds and, to a lesser extent, to great blue heron from the ingestion of mercury in fish tissue (EEQs of 49.9 for DDT compounds and 5.8 for mercury, respectively). However, the average concentrations of DDD detected in all fish species collected

<sup>6</sup> Toxicity values could not be found in the scientific literature to evaluate the potential for heptachlor to adversely affect great blue heron.

from the Main Ditch were below those detected in either catfish or bass collected from local areas and below those detected in fish species collected as part of the NCBP (see Figure 4-4) suggesting potential predators could be exposed to DDD at both off-site and on-site locations, and in some cases, to potentially higher concentrations at off-site locations. As discussed above, mercury was not detected in the sediment and surface water at any location in OU3. Furthermore, the arithmetic mean concentrations of mercury detected in all fish species collected from on-site locations remained below the average concentration detected in fish sampled regionally (Block 1990, Pinkney et al. 1995) and below the geometric mean concentrations detected in fish sampled as part of the NCBP (Schmitt et al. 1990). These results suggest the mercury detected in fish tissue may not be originating from OU3 and suggest, once again, that potential predators could be exposed to elevated mercury concentrations at both off-site and on-site locations.

#### 4.4.2 Aquatic Life

##### 4.4.2.1 Sediment

In this section of the ERA, the average (where applicable) and maximum concentrations of the COPC in the surface water of the OU3 are compared to the available toxicity values. The comparisons are shown in Table 4-9 and discussed below. Concentrations of all chemicals exceeding the available toxicity guidance values are plotted for each sample location in Appendix A.3.

*Summary of Sediment Results.* Sixteen PAHs, three pesticides, and one PCB were detected in the sediment collected from OU3. With the exception of dibenzo(a,h)anthracene, the maximum concentrations of all PAHs exceeded the ER-Ls (EEQs ranging from 1.3 for fluoranthene to 81.9 for acenaphthene) or other available toxicity values (EEQ of 1.1 for indeno(1,2,3-c,d)pyrene and 1.4 for benzo(b)fluoranthene). However, only the maximum concentrations of acenaphthene, 2-methylnaphthalene, and naphthalene exceeded the ER-M (EEQ ranging from 1.4 for naphthalene to 2.7 for 2-methylnaphthalene). The maximum concentrations of the pesticide chlordane (total), its constituent alpha- and gamma-chlordane, and DDD also exceeded both the ER-Ls (EEQs ranging from 12 for DDD to 526 for chlordane) and ER-Ms (EEQs ranging from 1.2 for DDD to 43.8 for chlordane[total]). PCB-1260 was also detected at a maximum concentration above the available toxicity value (EEQ of 1,208).

Barium and lead were detected at concentrations above background and identified as COPC. The maximum concentration of lead just exceeded the ER-L (EEQ of 1.8), but remained below the ER-M. No applicable toxicity value could be found in the scientific literature for barium and the potential for this chemical to adversely affect benthic-dwelling organisms could not be evaluated.

The results of the above comparisons indicate the potential for adverse effects to aquatic life from the presence of several organic compounds in sediment. Of the organic chemicals detected in sediment, PCB-1260 has the greatest potential to adversely affect benthic organisms. PCB-1260 was detected in sediment at the highest concentrations relative to the available TRVs. Furthermore, PCB-1260 was detected at all locations downgradient of the discharge ditch from the former oil/water separator and the former wash rack (RISD 31 through 35; see Appendix A.3).

The pesticides chlordane and DDD also have the potential to adversely affect aquatic life. Both compounds had maximum concentrations exceeding the ER-L and ER-M. However, both compounds were detected at only two of ten sample locations: chlordane was detected at RISD27 and 28 while DDD was detected at RISD27 and 35 (see Appendix A.3). Accordingly, if adverse effects are occurring as a result of pesticides, the effects would be expected to occur at only a limited number of locations.

As discussed above, sixteen PAHs were detected in sediment. With the exception of naphthalene and phenanthrene, PAHs were detected at concentrations above the available toxicity values in no more than two of the ten sample locations. Furthermore, with the exception of four PAHs (acenaphthene, indeno(1,2,3-c,d)pyrene, 2-methylnaphthalene, and naphthalene), the detected PAHs consistently occurred at concentrations below the available ER-M values

suggesting that adverse effects, if occurring, would be limited predominantly to sensitive benthic organisms and/or life stages.

Lead was detected at concentrations just above the ER-L (EEQ of 1.8), and there is also a very limited potential for adverse effects to sensitive benthic organisms from the presence of lead in sediment. There is some uncertainty associated with the potential for barium to adversely affect benthic organisms as applicable toxicity values could not be found for this chemical.

#### 4.4.2.2 Surface Water

In this section of the ERA the arithmetic mean concentrations of the COPC in the surface water of OU3 are compared to available TRVs. The comparisons are shown in Table 4-10 and discussed below. Concentrations of all chemicals exceeding the available toxicity guidance values are plotted in Appendix A.4 for each sample location.

Fluoranthene, the only organic chemical detected in surface water, was detected at a maximum concentration less than the chronic toxicity value and it is reasonable to conclude this chemical will not adversely affect aquatic life. The inorganic chemicals aluminum, barium, cadmium, chromium, copper, lead, thallium, vanadium, and zinc were detected at concentrations above background and were identified as COPC. Of these chemicals, the average concentrations of aluminum, barium, copper, lead, and vanadium exceeded the available chronic toxicity values (EEQs ranging from 1.1 for copper to 150.6 for aluminum), while only the average concentration of aluminum exceeded the acute toxicity value (EEQ of 17.5).

The above comparison indicates there is the potential for adverse effects to aquatic life from the presence of several inorganic chemicals in the surface water of OU3. A number of mean concentrations of inorganic chemicals exceeded the chronic toxicity values (aluminum, barium, copper, lead, and vanadium), while aluminum concentrations exceeded the acute toxicity value. Among these inorganic chemicals, aluminum consistently exceeded both toxicity values to the greatest extent (see Appendix A.4). However, available information suggests the chemicals detected in surface water are unlikely to be originating from on-site locations. As discussed in Section 4.1.1, OU3 receives discharge from an area immediately to the north of the facility boundary. At the time the samples were collected, the area immediately north of the facility boundary was in the process of being cleared for a golf course and housing development. Furthermore, precipitation events occurred for several days prior to and during the collection of surface water samples and field notes indicate a relatively high silt content in the surface water samples collected from OU3 close to the northern facility boundary. It is likely the ongoing precipitation combined with the ongoing clearing activities resulted in the elevated concentrations of inorganics detected in surface water at OU3 and that previous on-site activities were not the primary source of these chemicals.<sup>7</sup>

### 4.5 UNCERTAINTIES

As in any ERA, the WRF ERA incorporates a number of uncertainties associated with the estimates of ecological risk. The general approach in this ERA has been to err on the side of conservatism. Accordingly, the risks in this ERA are likely to be overestimated rather than underestimated. However, a complete understanding of the uncertainties associated with the risk estimates is crucial to placing the estimated risks into proper perspective. The main areas of uncertainty associated with the ERA can be grouped under the following categories:

- Environmental Sampling and Analysis and Selection of Chemicals for Analysis;
- Identification of Exposure Pathways/Receptors for Evaluation and Exposure Parameter Estimation;
- Analysis of Toxicological Data; and
- Assessment of Risks.

The major uncertainties in each of these categories are discussed in the following sections.

<sup>7</sup> Only unfiltered samples were taken from surface water and dissolved concentrations could not be determined.

#### 4.5.1 Environmental Sampling and Analysis and Selection of Chemicals of Potential Concern

The major source of uncertainty in the environmental sampling and analysis is associated with the representativeness of the samples taken in surface water. As discussed in Section 4.1.1, the area immediately to the north of WRF, which comprises part of the drainage basin of OU3, was being cleared at the time samples were being collected. The samples were collected during a storm event and runoff from the cleared area most likely contributed to the elevated inorganic chemical concentrations observed in samples taken from the upper reaches of OU3. This "pulse" release of chemicals could overestimate the potential for adverse effects to aquatic life.

There is substantial uncertainty associated with the applicability of the fish tissue data to the evaluation of contamination at OU3. Available fish sampling information suggests fish were collected from the Main Ditch at a location just above the beaver dam, though some fish may have been collected at locations below the dam. As discussed earlier, the fish were collected at a location downstream of where the most downgradient sediment/surface water sample was taken. Although it is likely that fish captured in this area frequently move upstream into the area sampled in OU3, samples collected from this area could potentially over- or underestimate accumulation in the OU3 area, and thus, over- or underestimate potential risks. This potential problem is exacerbated for species, such as sunfish and crappie, which tend to be territorial, and thus, relatively immobile. For chemicals localized to the OU3 area, such as PCB-1260, the collection of fish from the downgradient areas is likely to underestimate risks.

In addition to the location at which fish samples were collected, there is uncertainty associated with the length of time at which the collected fish have been present in the Main Ditch. Several of the fish species collected at WRF are relatively mobile and may move out of the ditch into deeper waters during, for example, periods of environmental stress (e.g., temperature extremes). The dam currently creates a barrier precluding the movement of most fish species. Eels, however, are capable of exiting the water and passing over/around the dam. Further, it is unknown whether the dam can be periodically breached by fish species, such as during storm events. If the dam is breached by either eels or fish then there is the potential for these organisms to have recently entered the ditch from the Occoquan/Belmont Bay introducing uncertainty about the representativeness of the tissue concentrations sampled from the ditch at OU3. The length of time in which a eel/fish has been present in the Main Ditch could result in the under- or overestimate of the potential for accumulation in this water body.

#### 4.5.2 Identification of Exposure Pathways/Receptors for Evaluation and Exposure Parameter Estimation

A number of uncertainties are associated with the identification of potential receptor species and the potential exposure pathways by which these species could be exposed to COPC. Only limited exposure data was available for evaluating many of the potential exposure pathways selected for evaluation in the ERA. In the absence of detailed information, conservative assumptions had to be made in order to estimate exposure of potential ecological receptors to COPC on WRF. For example, it was assumed that heron and mink obtain all of the fish they ingest from OU3 at WRF. Furthermore, it was assumed in the initial analysis that all chemicals detected in fish tissue resulted from accumulation at on-site areas. As discussed in Section 4.4.1, much of the chemicals accumulated in fish tissue are likely to have originated from areas outside of WRF. These assumptions could potentially overestimate the potential for adverse effects to ecological receptors from the ingestion of fish tissue.

There is also uncertainty associated with the potential exposure pathways selected for evaluation in the ERA. For example, the potential for adverse effects to terrestrial wildlife from the dermal absorption or inhalation of chemicals could not be evaluated because of a lack of exposure data. However, based on the COPC detected in the sampled media these potential exposure pathways are unlikely to occur or to result in adverse effects to terrestrial species and the inclusion of these pathways is unlikely to significantly alter the risk estimates.

#### 4.5.3 Analysis of Toxicological Data

There are a number of uncertainties associated with the toxicity values used for the evaluation of potential adverse effects to ecological receptors. There is uncertainty associated with the applicability of

the available toxicity data to the species occurring on WRF. For example, the NOAA ER-L/ER-M values were used to evaluate the potential for adverse effects to benthic organisms in many of the ephemeral surface water bodies on WRF. These toxicity values were derived largely for brackish water habitats and may not be relevant to the aquatic life occurring in the freshwater bodies on WRF.

For the evaluation of potential adverse effects to heron and mink from the ingestion of fish and sediment it was assumed that all of the mercury in fish tissue is present as methylmercury. Because the toxicity of inorganic mercury is always less than the toxicity of methylmercury, and methylmercury is the most toxic form of organic mercury (Eisler, 1987), this assumption is likely to overestimate risks if some fraction of the mercury is present in fish tissue as inorganic mercury.

#### **4.5.4 Assessment of Risks**

There are uncertainties associated with the assessment of risks in the ERA. The most apparent uncertainty is the extrapolation of assumptions about the potential for adverse effects from individual organisms to populations or communities. For the higher trophic level terrestrial species, the ERA made conclusions about the potential for adverse effects to individual organisms. Very few models are available to extrapolate the potential for adverse effects from the individual level to the population or community-level. Because of the limited availability of such models, certain assumptions had to be made about the overall potential for adverse effects to ecological receptors. It was generally assumed if there is no potential for direct adverse effects to individual organisms then it is also unlikely for there to be the potential for direct adverse effects to populations or communities. Similarly, it was assumed that if there is the potential for adverse effects to individual organisms there is also the potential for adverse effects to populations or communities. Risks may have been overestimated by this latter assumption.